British Civil Airworthiness Requirements

Section R
Radio

Issue 4

Civil Aviation Authority London

ACKNOWLEDGEMENT

The Civil Aviation Authority has pleasure in acknowledging its indebtedness to the Institution of Electrical Engineers for the closely co-ordinated effort which was made by its Committee on Radio Equipment for Civil Aircraft to revise the text of Issue 3 of Section R.

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CIVIL AVIATION AUTHORITY

BRITISH CIVIL AIRWORTHINESS REQUIREMENTS

PAPER NO. 727

SECTION R
RADIO

21st November, 1980

AIRCRAFT RADIO SYSTEMS

DISPLAY OF CHANNEL DATA

INTRODUCTION

The requirements of this Paper were agreed by the Co-ordinating Committee for Radio Requirements on 3rd July 1980 and are made effective upon acceptance of the advice of the Airworthiness Requirements Board.

TEXT OF AMENDMENTS

Material differences between the current requirements of Section R and those of this Paper are indicated with a marginal line.

The current R2-1, 2.10 and Note is deleted and the following is inserted:-

CHAPTER R2-1

Paragraph 2 GENERAL

2.10 Where a navigation or communication system is provided with selectable channels, provision shall be made to enable the flight crew to check which channel has been selected.

NOTES: (1) For DME systems incorporating a DME frequency hold selector, it is permissible for the DME channel to be held at the last selected frequency while the channel selector and associated frequency display are used to tune the normally paired VOR/ILS system to a new channel. In such circumstances, provision will have to be made to enable positive identification by the flight crew of the DME beacon by means of the DME audio identification signal.

(2) See also R4-2, 6.1.5 for display of channel data to the flight crew. In all cases it is recommended that the indication of the channel in use is of the actual frequency, and not in coded form.

CIVIL AVIATION AUTHORITY

BRITISH CIVIL AIRWORTHINESS REQUIREMENTS

SECTION R
RADIO

PAPER NO. 729

21st January, 1981

AIRCRAFT RADIO INSTALLATIONS IN TURBO-JET AEROPLANES

INTRODUCTION

This Paper amends Chapter R4-2. The changes were agreed by the Co-ordinating Committee for Radio Requirements and are in accordance with advice given by the Airworthiness Requirements Board.

TEXT OF AMENDMENTS

Material differences between the current requirements of Section R and those of this Paper are indicated with a marginal line.

In Chapter R4-2 the following is inserted in place of the current 6.1.

6.1 All controls, switches and indicators shall be so positioned that they can be operated and viewed by the appropriate member of the flight crew without undue strain or fatigue. Where necessary to prevent the possibility of confusion the controls shall be provided with a durable means of identification of their function.

NOTE: Reference should also be made to the appropriate Section for requirements for controls and instruments; for large aeroplanes see JAR 25.671(a), 25.1301 and 1309 (a), for light aeroplanes see K4-8 and K6-1 and for rotorcraft see G4-8 and G6-1.

In Chapter R4-2 the following new paragraph is inserted.

6.1.7 For turbo-jet aeroplanes certificated in the Transport Category, radio equipment with manually selectable frequency control shall be of a type where the radio frequency is selected incrementally and displayed as easily read characters.

CIVIL AVIATION AUTHORITY

BRITISH CIVIL AIRWORTHINESS REQUIREMENTS

SECTION R
RADIO

CORRIGENDUM NO.1 TO

BLUE PAPER NO. 729

27th February 1985

AIRCRAFT RADIO INSTALLATIONS IN TURBO-JET AEROPLANES

INTRODUCTION

Blue Paper No. 729 introduces amendments to Chapter R4-2 arising from Airworthiness Notice No.85 which requires ADF equipment to be incrementally tuned. When work started on the paper Notice 85 applied only to turbine-engined aeroplanes. This applicability was extended by Issue 2 of the Notice to include turbine-engined helicopters certificated in the Transport Category in Performance Group A, but this extension was not reflected in Paper 729.

TEXT OF AMENDMENTS

This Corrigendum amends Blue Paper 729 to align with Issue 2 of Airworthiness Notice No. 85 as follows:-

Amend title by adding "AND TURBINE ENGINED HELICOPTERS".

Amend new R4-2, 6.1.7 by inserting the underlined words so that it reads:-

"6.1.7 For turbo-jet aeroplanes certificated in the Transport Category, and turbine engined helicopters certificated in the Transport Category in Performance Group A, radio-equipment with manually selectable frequency control shall be of a type where the radio frequency is selected incrementally and displayed as easily read characters."

CONTENTS

SECTION R—RADIO

SECTION R

Issue 4, 10*th April*, 1974

EXPLANATORY NOTE

1 INTRODUCTION The changes introduced into Issue 4 of Section R are listed in this Note. The full extent of amendments to any particular Chapter or Appendix can be determined by reference to the marginal lines in the appropriate Chapters or Appendices.

2 TECHNICAL CHANGES

2.1 **Chapter R1—1 General.** Account has now to be taken of increased complexity of radio systems, and the importance of compatibility of apparatus. Account is required to be taken of the possible noxious effects of materials.

2.2 **Chapter R1—2 Definitions.** Definitions of terms associated with probabilities are introduced.

2.3 **Chapter R2—1 Aircraft Radio Systems—General.** This Chapter now reflects the current practice of evaluation of the complete aircraft systems. Generally, the severity of requirements relating to the extent of tests and analyses, is related to the possible consequences of failure of each particular system. Requirements are prescribed for Intercommunication Systems into which are fed radio communication or audible warnings. Safeguards against warning devices creating interference with normal functioning of the associated system are introduced. An Appendix has been added to indicate special areas which experience has shown to be of particular significance.

2.4 **Chapter R3—1 Radio Apparatus—Approval.** The Chapter will be consistent with its corresponding Chapter in Section A (Chapter **A3—4**). Provision is made for a Declaration of System Characteristics.

2.5 **Chapter R3—2 Radio Apparatus Approval Category Unrestricted.** The design of high-powered transmitters and associated equipment is required to be such as to minimise the risk of flashover. The requirements for safety precautions have been re-presented. Criteria for the compass safe distance of head sets and hand-held microphones are introduced.

2.6 **Chapter R3—3 Radio Apparatus Approval Category Restricted.** The requirements for LA Class 1 apparatus have been amended so as to be on similar lines to those for Unrestricted Equipment. Additionally, the upper limit of the temperature range over which the apparatus has to meet the requirements is increased to 50°C. The requirements for LA Class 2 apparatus have been amended only in that a declaration of compass safe distance is now required, and the upper limit of compliance is changed to 50°C. The requirements for LA Class 3 have been amended only in respect of a declaration of compass safe distance. The requirements for Approval Category G are unchanged.

2.7 **Chapter R4—1 General.** The only change of significance, other than minor amendments to clarify intention, is one which attempts to reduce the number of placards and notices.

2.8 **Chapter R4—2 Installation.** Identification of wires, cables or connectors is now covered in broad terms. The necessity for bonding non-metallic conducting materials is emphasised. Forced air cooling systems for essential services have now to be duplicated. Labelling is limited to where it is necessary to prevent the possibility of confusion. Requirements for the design and control of communication/transmitter and inter-communication systems are clarified.

2.9 **Chapter R4—3 Power Supplies and Circuit Protection.** The amendments to this Chapter are of a minor nature.

2.10 **Chapter R4—4 Aerial Systems.** Unwanted radio frequency energy radiated inside the aircraft has to be minimised. The level of acceptable electrical interference between aerials, and between aerials and apparatus, is now related to the performance capabilities of the affected systems. Account is required to be taken of the presence of liquids on and in the undersurfaces of the aircraft. The requirements for waveguide contamination are more realistic. The requirements for damage resulting from aerial/aircraft movement and aerial breakage are revised. The effect of ice accretion on whip aerials is re-considered. Consideration of the effects of ice shed from aerials is extended to the functioning of essential services.

2.11 **Chapter R4—5 Bonding and Lightning Discharge.** Requirements relating to lightning strikes on aerials are revised. Reduction in performance of an aerial when its associated radome is protected against lightning discharges is covered. The detailed requirement for earthing connections has been re-written in general terms.

2.12 **Chapter R4—6 Ground and Flight Tests.** This Chapter has been revised to present the requirements for compliance with Minimum Operational Performance Requirements in very broad terms with acceptable means of compliance for specific equipment detailed in its Appendices.

2.13 **Chapter R4—7 Interference from Precipitation-static.** Each installation is now to be treated on its merits.

3 PRESENTATION Section R is now presented in loose Chapter form (previously it was a bound volume). The loose Chapter form enables individual Chapters or Appendices to be revised and replaced without reprinting the whole of the Section.

4 PAPERS INCORPORATED The following BCAR Blue Papers have been incorporated in this Issue 4 of Section R:—

517 Chapter R4—1 – General – Section R.
518 Chapter R4—2 – Installation – Section R.
519 Chapter R4—3 – Power Supplies and Circuit Protection – Section R.
520 Chapter R4—4 – Aerial Systems–Section R.
521 Chapter R4—5 – Bonding and Lightning Discharge Protection – Section R.
522 Chapter R4—6 – Ground and Flight Tests – Section R.
548 Chapter R4—7 – Interference from Precipitation–static – Section R.
572 Tests for VHF Communication Systems – Section R.
573 Tests for ADF Systems – Section R.
580 Tests for VOR, ILS and Marker Systems – Section R.
582 Tests for Weather Radar Systems – Section R.
585 Tests for Intercommunication and Audio-Integration Systems – Section R.

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FOREWORD—SECTION R

Revised, 10th April, 1974

1 PURPOSE British Civil Airworthiness Requirements (hereinafter referred to as the "Requirements") of which Section R is a constituent part, are published by the Civil Aviation Authority (hereinafter referred to as the "CAA"). They comprise minimum requirements applicable to the design and testing of radio apparatus, and the design and testing of aircraft radio communication and radio navigation installations, and constitute the basis for the issue of approvals and certificates required by the Air Navigation Order.

2 INTERPRETATION

2.1 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.

2.2 Where necessary, the Requirements are supplemented by Appendices printed in blue for easy recognition. Generally these Appendices take the form of acceptable interpretations of requirements, state recommended practices, give supplementary information, or detail acceptable methods by which compliance with the requirements may be shown. Where an Applicant does not wish to show compliance in accordance with an Appendix, alternative methods will have to be acceptable to the CAA.

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

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

3 PRESENTATION

3.1 **Arrangement of Requirements.** This Section R is so arranged that requirements of general applicability are presented at the beginning of appropriate parts of the Section. For example R1—1 "General" prescribes requirements for materials and components, which are applicable to the whole of Section R. This arrangement avoids the need for frequent repetition of such generally applicable requirements. Thus—

(a) Sub-section R1, General and Definitions (Chapters **R1—1** and **R1—2**) is applicable to the whole of Section K.

(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 R1 and at least the General Chapter for the Sub-section in which the particular requirements in which he is interested appear.

3.2 Editorial

3.2.1 Section R is divided by subjects into sub-sections numbered consecutively. The sub-sections are further divided into chapters, the number of each chapter being associated with its sub-section (e.g. Sub-section R4 contains Chapters R4—1, R4—2, R4—3 etc., up to R4—7).

3.2.2 A list of the subjects covered by the sub-sections and chapters is given in the CONTENTS. In addition, the subjects of individual paragraphs are included in the INDEX.

3.2.3 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.

3.2.4 In the absence of any indication to the contrary requirements and recommendations are applicable to all aircraft.

3.2.5 The method of indicating that a requirement is applicable only to aircraft of a specific weight range, to special conditions of certification, or to aeroplanes having specified technical features, is an appropriate reference in the paragraph title or text.

3.2.6 Where for the purposes of the requirements, terms must carry a particular meaning, definitions are given in appropriate places throughout this Section R. Thus, where the defined meanings apply throughout the Section, the definitions appear in Chapter **R1—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 3.1. For definitions of other terms see **R1—2, 1.** Those terms a definition of which appears in this Section R are distinguished by initial capital letters, e.g. "Radio Apparatus" and reference to the Index will give the location at which a definition of the term can be found.

3.3 S.I. Units

3.3.1 "S.I." is the accepted symbol for "Système International d'Unites" (International System of Units) and this system is being introduced into the Requirements as and when new or revised Chapters are published.

3.3.2 In general, where a unit in the current text has been converted to an S.I. Unit a conveniently rounded-off value of the S.I. Unit is used. In this case and where a new requirement is introduced an S.I. Unit is used and an equivalent value expressed in the existing unit is also shown, e.g. 30 cm (12 in). Where S.I. Units already appear in the Requirements, e.g. "20°C", equivalent non-S.I. Units (in this example "°F") will not be added.

3.3.3 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 with a direct equivalent of the unit replaced, e.g. "12,500 lb" has become "5700 kg". 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.

4 ISSUE AND AMENDMENT

4.1 A suitable announcement will be made in the Aeronautical Press whenever a new issue of the Section is made.

4.2 In each Chapter or Appendix, material differences from the previous issue of that Chapter or Appendix are indicated with a marginal line. However, in order to facilitate recognition, a Chapter or Appendix will be marginally lined throughout when it is first issued.

4.3 The issue or revision date is shown on the title page of each Chapter and Appendix. The significance of the wording is as follows:—

(a) *Issued*—the first version to appear in the Section.

(b) *Revised*—the whole Chapter or Appendix has been reviewed, and is considered to be amended and up-to-date at the time of publication as a revised Chapter or Appendix.

NOTE: In some instances although a Chapter has been revised and is annotated accordingly it may not have been necessary to make any amendments to its Appendix; in such cases the Chapter and its Appendix would bear different dates.

(c) *Revised in part*—only those paragraphs carrying text annotated with a marginal line have been reviewed and amended; the whole Chapter or Appendix has not been reviewed. It is not to be assumed, however, that paragraphs not annotated with a marginal line are out of date.

5 EFFECTIVE DATE New requirements and amendments introduced into this Section become effective on the date printed on the issue in which they first appear.

6 APPLICATIONS AND ENQUIRIES Applications for further copies of this Section should be addressed to the Civil Aviation Authority, Printing and Publication Services, Greville House, 37 Gratton Road, Cheltenham, Glos., GL50 2BN. 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, Airworthiness Division, Brabazon House, Redhill, Surrey, RH1 1SQ.

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SUB-SECTION RI—GENERAL AND DEFINITIONS

CHAPTER RI—1 GENERAL

Revised, 10th April, 1974

1 INTRODUCTION The requirements of this Sub-section are those of a general nature applicable to Section R as a whole.

NOTE: Section R does not specify requirements for the performance of radio apparatus; Operational Classification of, and Minimum Performance Requirements and Minimum Operational Performance Requirements for, airborne radio apparatus are published by the Civil Aviation Authority in Civil Aviation Publication 208—Airborne Radio Apparatus (CAP 208, Vols. 1 and 2). Compliance with Minimum Performance Requirements is a prerequisite of approval of Radio Apparatus (see e.g. **R3—2**, 7.1.1.). Compliance with Minimum Operational Performance Requirements can be demonstrated by showing compliance with this Section R (see e.g. **R4—6**).

2 APPLICABILITY

2.1 The requirements of this Section are applicable to:—

(a) Radio (and radar) equipment, i.e. equipment concerned with information transfer by the use of radiated electro-magnetic waves.

(b) Those transducers which deal with information mainly obtained from radio channels. Examples are inter-communication equipment, positional map displays and visual indicators of the instrument or cathode-ray type.

NOTE: The classification of a system as being subject to the requirements of this Section from the aspect of design requirements does not necessarily appiy in other spheres such as the maintenance procedure of operators.

2.2 Other Sections of the Requirements, in addition to this Section, can apply to particular items of radio equipment. For example, for strength requirements and for requirements applicable to the operation of essential services following power-unit failure, reference should be made to the Section applicable to the particular aircraft (e.g. **Section D** for aeroplanes, **Section G** for rotorcraft).

2.3 Where reference is made in the requirements to British Standards (BS) or other Specifications, such reference shall be taken to refer to the current issue (with amendments) of the Standard or Specification.

3 COMPLIANCE WITH REQUIREMENTS

3.1 **General**

3.1.1 The requirements of this Section R are intended primarily for the Aircraft Design Organisation, on whom rests the final responsibility for ensuring that an acceptable standard of airworthiness is achieved.

3.1.2 In the case of complex Aircraft Radio Systems it will normally be necessary to employ the services of Aircraft Radio Systems designers. The Aircraft Design Organisation may nominate these individuals, or the equipment manufacturer may be relied upon to make suitable appointments.

3.2 **Responsibilities.** The requirements have been written in terms which allow for segregation of responsibilities based on the principles laid down in this paragraph 3.2.

3.2.1 **Aircraft Design Organisation.** It is the responsibility of the Aircraft Design Organisation:—

(a) For all selected Radio Apparatus*, Radio Equipment* and Aircraft Radio Systems* to ensure that—

(i) Compliance is shown with all requirements relevant to the apparatus, equipment or system (e.g. for an Aircraft Radio System in Approval Category Unrestricted, the requirements of **R1—1, R2—1, R3—1** and **R3—2**).

NOTE: Coverage of all applicable requirements reflected in Declarations of Design and Performance (DDP's)† (or Declarations of System Characteristics (DSC's))† for the Radio Apparatus and Aircraft Radio Systems, together with the declarations of the Design Organisation applying for approval of the Radio Apparatus or Aircraft Radio System in the aircraft, will normally be an acceptable method of demonstrating compliance.

(ii) It is so installed that the requirements of this Section and all other relevant requirements in the Section appropriate to the aircraft are complied with.

(b) To ensure that Aircraft Radio Systems designers are appointed where necessary.

3.2.2 **Radio Apparatus Designer.** It is a Radio Apparatus designer's responsibility:—

(a) To ensure that the requirements detailed in the DDP appropriate to the item have been complied with, and that the performance of the apparatus is established and declared.

(b) To provide such information as is necessary to enable the Aircraft Radio Systems designers and the Aircraft Design Organisation to show compliance with 3.2.3 and 3.2.1 respectively.

3.2.3 **Aircraft Radio System Designer.** It is an Aircraft Radio System designer's responsibility:—

(a) To ensure that the Radio Equipment comprising an Aircraft Radio System is compatible both within the system and with other systems (including other Aircraft Radio Systems) and devices in the aircraft in which the Aircraft Radio System will be installed.

(b) To provide such information as is necessary to enable the Aircraft Design Organisation to show compliance with 3.2.1.

4 MATERIALS AND COMPONENTS

4.1 Materials which are known to be unsatisfactory for use in radio equipment shall not be used. Equipment shall, as far as is practicable, be constructed of low flammability materials and materials which will not emit toxic or noxious fumes. Other materials shall be so applied and/or protected that the risk of fire is not increased by their use.

NOTE: Specific requirements covering fire, explosion and noxious fumes are prescribed in **R3—2.**

4.1.1 Where materials are used which can, under circumstances likely to occur, present a hazard to the health of maintenance personnel, precautions shall be taken to reduce that hazard to a minimum.

NOTE: It is strongly recommended that the use of any such materials is indicated in the DDP, in all Maintenance, Overhaul and Repair Manuals, and on the equipment itself. Particular attention should be drawn to precautions associated with beryllium oxide.

*For definition see **R1—2, 3.**

†See **R3—1, 3.**

4.2 Materials, the surfaces of which are known to be liable to corrosion or to the growth of fungus under the expected operating conditions, shall not normally be used. Such materials may be used only if they are so protected as to prevent the occurrence of these effects, and in this case appropriate tests may have to be made.

4.3 The risk of corrosion by electrolytic action shall be reduced to a minimum. So far as is practical the juxtaposition of dissimilar metals shall be avoided.

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

4.4 **Components.** All component items, both active and passive, shall be of types which are established as suitable for the particular application.

NOTE: The CAA may require evidence that the Radio Apparatus or Aircraft Radio System designer and the component designer have appropriately collaborated on the specification and application of the component item.

5 CURRENT PRACTICE AND DEVELOPMENT

5.1 The requirements are written in terms of conventional materials, appliances and methods. Unconventional materials, appliances and methods which result in an equivalent level of safety may be used, provided that the CAA is consulted at an early stage in the design.

5.2 Good workmanship at all stages of the construction of equipment is required for compliance with the requirements of this Section.

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SUB-SECTION RI—GENERAL AND DEFINITIONS

CHAPTER RI—2 DEFINITIONS

Revised, 10th April, 1974

1 INTRODUCTION This Chapter gives definitions essential to the accurate interpretation of the requirements of Section R. In the main, definitions of other terms are consistent with the Glossaries of Aeronautical Terms and Terms used in Terms Common to Power, Telecommunications and Electronics published by the British Standards Institution as BS 185 and 4727 Part 1 respectively, and the Air Navigation Order*.

2 GENERAL

2.1 **Applicant.** A person applying for approval of an aircraft or any part thereof.

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

2.3 **BS 3G.100.** British Standard 3G.100 "Requirements for Equipment in Aircraft".†

2.4 **BS 2011.** British Standard 2011 "Methods for the Environmental Testing of Electronic Components and Electronic Equipment."†

2.5 **The CAA.** The Civil Aviation Authority.

2.6 **CAP 208.** Civil Aviation Publication 208—Airborne Radio Apparatus, Volumes 1 and 2.

3 RADIO

3.1 **Radio Apparatus.** A discrete radio appliance which can be readily connected into, and removed from, an Aircraft Radio System.

3.2 **Radio Equipment.** An item which is part of an Aircraft Radio System.

3.3 **Aircraft Radio System.** An association of items which together perform a declared operational function (e.g. a navigational system).

4 TERMS ASSOCIATED WITH PROBABILITIES

4.1. **Occurrences.** An Occurrence is a condition involving a potential lowering of the level of airworthiness.

*Obtainable from Her Majesty's Stationery Office, York House, Kingsway, London W.C.2.

†British Standards are obtainable from the British Standards Institution, British Standards House, 2 Park Street, London, W.1.

4.2 **Probability* of Occurrences**

4.2.1 **Frequent.** Likely to occur often during the operational life of each aircraft of the type.

4.2.2 **Reasonably Probable.** Unlikely to occur often during the operation of each aircraft of the type, but which may occur several times during the total operational life of each aircraft of the type.

4.2.3 **Recurrent.** A term embracing the total range of Frequent and Reasonably Probable.

4.2.4 **Remote.** Unlikely to occur to each aircraft during its total operational life, but which may occur several times when considering the total operational life of a number of aircaft of the type.

4.2.5 **Extremely Remote.** Unlikely to occur when considering the total operational life of a number of aircraft of the type, but nevertheless, has to be considered as being possible.

4.2.6 **Extremely Improbable.** So Extremely Remote that it does not have to be considered as possible to occur.

4.3 **Effects.** An Effect is a situation arising as a result of an Occurrence.

4.3.1 **Minor Effect.** An Effect which can be readily counteracted by the flight crew; it may involve:

(a) small increase in flight crew workload, or
(b) moderate degradation in performance or handling characteristics, or
(c) slight modification of the permissible flight envelope.

4.3.2 **Major Effect.** An Effect which produces:

(a) significant increase in flight crew workload, or
(b) significant degradation in performance or handling characteristics, or
(c) significant modification of the permissible flight envelope,

but will not remove the capability to continue a safe flight and landing without demanding more than normal skill on the part of the flight crew.

4.3.3 **Hazardous Effect.** An Effect which produces:

(a) a dangerous increase in flight crew workload, or
(b) dangerous degradation of performance or handling characteristics, or
(c) dangerous degradation of the strength of the aeroplane, or
(d) marginal conditions for, or injury to, occupants.

4.3.4 **Catastrophic Effect.** An Effect which results in the loss of the aircraft and/or in fatalities.

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*Where numerical probabilities are used in assessing compliance with requirements using the above terms, the following approximate values may be used to assist in providing a common point of reference. The probabilities quoted should be on an hourly or per flight basis, depending on which is more appropriate to the assessment in question:

Frequent	Greater than 10^{-3}
Reasonably Probable	10^{-3} to 10^{-5}
Remote	10^{-5} to 10^{-7}
Extremely Remote	Less than 10^{-7}
Extremely Improbable	While no approximate numerical probability is given for this, the figures used shall be sufficiently less than 10^{-7} for the total probability of a catastrophe from all systems to be less than 10^{-7}.

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SUB-SECTION R2—AIRCRAFT RADIO SYSTEMS

CHAPTER R2—1 GENERAL

Revised, 10*th April,* 1974

1 INTRODUCTION The requirements of this Chapter **R2—1** are applicable to each Aircraft Radio System. In showing compliance with the requirements, account may be taken of the total information provided by the equipment (radio and non-radio) installed in the aircraft, together with the information on the equipment provided for the flight crew (e.g. manuals, placards).

2 GENERAL (see R2—1 App., 2 and 3)

2.1 Aircraft Radio Systems shall be so designed and installed that they perform their intended functions under the conditions of operation for which they are required.

NOTES: (1) The minimum requirements for the carriage of equipment are contained in the Air Navigation Order*, and Minimum Operational Performance Requirements are contained in CAP 208.

(2) Installation requirements are prescribed in **R4—1** and **R4—2.**

2.2 Aircraft Radio Systems shall be so designed and installed that they are suitable for use by the flight crew for their intended purpose.

2.3 Aircraft Radio Systems shall be so designed and installed as to avoid hazards to the aircraft in the event of their failure or malfunction.

2.4 Where Aircraft Radio Systems are interconnected with other systems on the same aircraft, there shall be no significant degradation of any of the interconnected systems.

2.5 Where, in showing compliance with the requirements of 2.1, 2.2, 2.3 and 2.4, reliance is placed on the fact that an Aircraft Radio System will behave in a predictable manner, information sufficient to determine that the behaviour is as predicted, together with an assessment of the confidence that can be placed in the behaviour being as predicted, shall be declared. The level of confidence shall be such as not to invalidate any assumptions made.

NOTE: Particular attention should be given to:—

(a) The effects of stimuli external to the aircraft, e.g. thunderstorms.

(b) Indications that correct behaviour is restored after temporary upsets.

(c) Limit of variations after which information should not be accepted.

2.6 The Applicant shall ensure that such tests and failure and safety analyses as are necessary to establish compliance with the appropriate requirements of this Chapter **R2—1** and **R4—1** are done.

NOTE: The extent of the failure and safety analyses may thus vary between a simple statement of consequences of failure on the output of a system, to a detailed investigation of those parts of the system on which the airworthiness of the aircraft is dependent.

2.6.1 Where tests are necessary, the schedule of tests shall be agreed in consultation with the CAA.

*Published by Her Majesty's Stationery Office, Kingsway, London W.C.2.

2.7 All controls required for operation in flight shall be so designed and located as to permit satisfactory use and to guard against their accidental movement without the knowledge of the appropriate member of the flight crew.

NOTE: See also **R4—2,** 6.1 for requirements for means of identification of function.

2.8 Controls and instruments shall conform to operating conventions which are compatible with equivalent systems in the aircraft.

2.9 The means of tuning transmitters and receivers, whether the selection be continuous or discrete, shall be so designed that when tuned to an identified station, channel or frequency, the risk of unintended de-tuning is Remote.

2.10 Where a navigation or communication system is provided with selectable channels, the frequency channel to which the system is tuned shall be legibly and unambiguously displayed.

NOTE: See also **R4—2,** 6.1.5 for display of frequency to the flight crew. In all cases it is recommended that the indication of the channel in use is of the actual frequency, and not in a coded form.

2.11 Information, additional to that required by **Section A,** Chapters **A6—1** and **A6—7,** shall be provided where it is considered that the provision of information to the flight crew on such matters as special operational characteristics, interpretation of warnings, etc., is essential for the safe operation of the aircraft.

3 COMMUNICATION SYSTEMS (see R2—1 App., 2) In addition to compliance with **2,** communication systems shall also comply with this paragraph **3.**

3.1 Communication systems shall be so designed that the probability of operation on a channel other than that appropriate to the setting of the controls is Remote.

3.2 Provision shall be made for maintaining reception watch on communication systems during intervals between the actual transmission from the associated transmitter.

3.3 When communication transmitter power supplies are intended to be switched off during prolonged periods of reception, the time required to initiate a transmission shall not exceed 30 seconds.

4 INTERCOMMUNICATION AND AUDIO-INTEGRATION SYSTEMS In addition to compliance with **2,** intercommunication and audio-integration systems* shall also comply with this paragraph **4.**

4.1 Intercommunication and audio-integration systems shall be so designed that any Reasonably Probable failure within the system, or within any associated warning system, will not result in a reduction of performance such as to create a Major Effect.

4.2 Where alarm signals are received and reproduced (e.g. from a central warning system) the warning signal characteristic shall be suitably related to the importance of the warning.

NOTE: Significant impairment of normal functioning would only be acceptable when related to emergency conditions demanding immediate action disassociated from the use of the other services provided by the system.

*For the purposes of this Chapter, defined as "A system in which radio communication or audible warnings, or both, are fed into an intercommunication system."

5 NAVIGATION SYSTEMS (see R2—1 App., 3) In addition to compliance with **2,** navigation systems shall also comply with this paragraph **5.**

5.1 **General.** Navigation Systems shall be so designed that the probability of misleading information on the position of the aircraft being presented without an adequate failure warning indication is Remote.

5.2 **Warning Devices**

5.2.1 Warning devices shall be of such a nature and shall operate with such rapidity as is compatible with the degree of danger which would otherwise be introduced by the incorrect information.

NOTE: Where the output from a navigation receiver is processed by a navigational computer, it may be necessary to provide additional warning devices.

5.2.2 The characteristics of the failure warning arrangements shall be considered in the failure analyses and shall be declared.

5.2.3 Where warning devices are closely associated with a visual display, their design shall be such that when not in the warning mode they are unlikely to affect adversely the normal display.

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APPENDIX TO CHAPTER R2—1

Issued, 10th April, 1974

AIRCRAFT RADIO SYSTEMS—GENERAL

1 INTRODUCTION

1.1 **General.** This Appendix contains information on suitable methods of compliance with Chapter **R2—1** for specific classes of Aircraft Radio Systems. An analysis of those characteristics of each particular design which are critical and of airworthiness significance should be done. It is considered to be useful, however, to indicate some of the special areas which experience has shown to be of particular significance.

1.2 **Safety and Failure Analyses.** Safety and failure analyses may be either theoretical or empirical, or a combination of both.

2 COMMUNICATION SYSTEMS (see R2—1, 2 and 3) The provisions of this paragraph **2** should be taken into account when demonstrating compliance with **R2—1, 2** and **3.**

2.1 **General**

2.1.1 Where multiplicity is introduced into a system (e.g. to permit the simultaneous use of more than one VHF transmitter-receiver) compatibility between the various items of each sub-system and between those sub-systems themselves should be ensured.

(a) In such systems it may well be that transmitter-receivers which will be operating simultaneously will need to be substantially superior to transmitter-receivers which operate alone. Characteristics such as spurious radiation, susceptibility to interference, and performance should be taken into account.

(b) The extent of the margin by which resistance to interfering conditions should be above that defined in the Minimum Performance Requirements (CAP 208) should be declared.

2.1.2 The failure analyses should include a detailed analysis of the potential failure conditions which could cause a system to operate on a channel other than that appropriate to the setting of the controls.

2.2. **ATC Transponders**

2.2.1 In showing compliance with **R2—1,** 2.4 it should be demonstrated that the probability of any failure or malfunction in the transponder affecting the accuracy of any altimeter connected to that transponder is Remote.

2.2.2 The analysis on ATC transponders should also be such as to demonstrate that the probability of an abnormal delay between the reception of the interrogating pulse and the transmission of the reply is Remote.

3 NAVIGATION SYSTEMS (see R2—1, 2 and 5) The provisions of this paragraph **2** should be taken into account when demonstrating compliance with **R2—1, 2** and **5.**

3.1 **ADF**

3.1.1 Connections and leads for the ADF loop aerial and receiver should be specially selected, and so specified and incorporated, as to achieve the highest practical reliability. Reference to the characteristics of these connections should be made in the DSC or DPP associated with the ADF system.

3.1.2 An assessment of the risk of the receiver operating on a channel other than that appropriate to the setting of the controls should be done and should show that this probability is Remote.

3.2 **DME**

3.2.1 Special attention should be given to the channel selection system and to co-channel interference and multi-path transmission effects.

3.2.2 A failure analysis should be done on the transmitter-receiver for assessment of the risk of indication of incorrect ranges.

3.3 **Doppler**

3.3.1 The system should be so designed that any change of operational mode (e.g. from the active to the memory state and vice versa) is indicated. Such indications should be closely associated with the Doppler display and should be separate from, and additional to, any failure warning device.

3.3.2 A failure analysis should be done to assess the risk of the display of incorrect information.

3.4 **Radio (Radar) Altimeters**

3.4.1 Where the display system consists of a conventional pointer instrument the characteristics should be in accordance with (a) and (b).

(a) Failure or malfunctioning should be indicated by the movement of the pointer beyond the zero position to an occluded position.

(b) Unless the degree of confidence declared for the means prescribed in (a) is adequate (see 3.4.2), the system should be such that additionally a warning flag is displayed in the event of failure or malfunctioning. The warning flag should be highly conspicuous, its visible area should be not less than 4% of the area enclosed by the calibrated scale, and it should obscure that portion of the scale between 0 and 100 feet. The major axis of the warning flag should be such that the flag is not parallel to either the calibrated scale, or the pointer, at the point at which intersection takes place.

3.4.2 A failure analysis should be done.

NOTE: Where the altimeter system is part of a major system (e.g. on automatic-landing system) it will probably be advantageous to carry out the analysis in collaboration with the designer of the major system.

3.5 **VOR**

3.5.1 The matching characteristics of the indicators and selectors intended for use with the receiver should be declared.

3.5.2 It will normally be necessary for an assessment of the risk of incorrect channel selection and indication of erroneous bearings to be made.

3.6 **Weather Radar**

3.6.1 Weather radar systems should be so designed that the information displayed is not unduly affected by aircraft manoeuvres and attitudes liable to occur in normal operations.

NOTE: This feature is a prerequisite of approval where the system is installed in order to comply with the Air Navigation Order. For other aircraft it is recommended that this feature be incorporated.

3.6.2 A failure analysis should be done on the range-marking system and on the system conveying angular data between the aerial and the other parts of the system.

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SUB-SECTION R3—RADIO APPARATUS

CHAPTER R3—1 APPROVAL

Revised, 10th April, 1974

1 INTRODUCTION The requirements of this Chapter are concerned with the approval of Radio Apparatus and are complementary to the requirements of **Section A,** Chapter **A3—4.**

2 GENERAL

2.1 The procedures for Design Approval and Series Inspection and Testing to be applied to the equipment are prescribed in **Section A,** Chapter **A3—4,** subject, however, to the discretion of the CAA.

NOTE: In particular circumstances, the CAA may grant restricted approval to certain items of apparatus and may limit the use of such apparatus to particular aircraft. Normally such approvals are for a limited period of time; they can usually be identified by the "Q" reference on the approval.

2.2 All items of Radio Apparatus shall, as appropriate to the Approval Category, be capable of operation in accordance with their declared performance in the environmental conditions (including power supply variations) stated in the Declaration of Design and Performance (see **3**).

2.2.1 The apparatus, when subjected to any of the appropriate tests of the specification on which the DDP is based, shall achieve a performance not less than the declared performance, and shall suffer no damage which could lead to unreliability in service or result in a temporary or permanent reduction in performance relative to the declared performance. The apparatus shall be capable of working in the manner declared during exposure to these conditions, and, if switched on under adverse ambient conditions, shall be capable of working satisfactorily after reasonable recovery time.

2.2.2 In showing compliance with 2.2, in addition to account being taken of response to power supply variations, account shall also be taken of such transient characteristics as could, for example, be caused by switching on and off other apparatus. Acceptable standards for such tests are contained in BS 3G.100.

3 DECLARATION OF DESIGN AND PERFORMANCE

3.1 General

3.1.1 The Declaration of Design and Performance required in accordance with **Section A,** Chapter **A3—4, 2,** shall include the information detailed in 3.2 and shall be prepared for each item of Radio Apparatus for which approval is sought.

NOTE: In addition to Radio Apparatus certain airframe parts and equipment are also covered by a Declaration of Design and Performance; for details of this document see **Section A,** Chapter **A3—3.**

3.1.2 Where approval is sought for a group of associated items of Radio Apparatus, the mutual characteristics of that group may be declared in a Declaration of System Characteristics in order to simplify the statements which need to be made in accordance with 3.2(e), provided that the Applicant undertakes responsibility for the group.

3.2 The Declaration of Design and Performance for apparatus approved in Approval Category Unrestricted shall contain the information prescribed in (a) to (k).

NOTE: In the case of Radio Apparatus specifically limited to Approval Category Restricted (see R3—1 App., 1.1) a limited Declaration of Design and Performance may be prepared. This declaration should include, at least, the information prescribed in (a), (c), (d), and basic installational information (see (f)).

(a) Particulars identifying the apparatus and its design standard, and including reference to the specification(s) to which it is designed, and a record of drawings.

(b) The apparatus performance specification, either directly, or by reference to other supplementary documents, where necessary.

(c) (See **R3—1** App., 1.1) A statement of the Approval Category together with the requirements with which the apparatus complies. The statement should be in terms of Sections, Chapters and paragraphs of the Requirements (with dates of Issue) together with any additional requirements which have been notified by the CAA in writing.

(d) Reference to relevant test reports, and failure analyses.

(e) (See **R3—1** App., 1.2) Reference to associated items of apparatus, or to appropriate Declarations of System Characteristics, together with information on the effects on performance and characteristics that could be expected when the apparatus is used in conjunction with other apparatus.

NOTE: The number of associated items to which reference is made is at the discretion of the Applicant.

(f) (See **R3—1** App., 1.3) Limiting conditions applicable to the use of the apparatus, including limitations implicit in the design declarations required by the governing specification, and the ability of the apparatus to work under various conditions.

(g) Any alteration in the basic performance characteristics of the apparatus which could occur because of variations in ambient conditions, power supply and similar factors.

(h) Electrical power consumption.

(j) Any other characteristic of the apparatus which needs to be known by the aircraft designer.

(k) Where apparatus is known to have features which are potentially capable of causing dangerous repercussions when incorporated into an aircraft, an assessment of the risk of that occurrence shall be stated.

3.2.1 The Declaration shall bear the following statement made and signed by the Chief Designer:—

"I hereby certify that the information contained in this Declaration of Design and Performance is accurate and is made under the authority of the Civil Aviation Authority Approved Organisation Ref. ABC. XYZ Ltd. will not accept responsibility for the satisfactory operation of apparatus used in conditions other than those given above without their agreement".

NOTE: Where a Declaration of System Characteristics is used, the wording should be modified accordingly.

APPENDIX TO CHAPTER R3—1

Issued, 10th April, 1974

RADIO APPARATUS—APPROVAL

I DECLARATION OF DESIGN AND PERFORMANCE

1.1 **Approval Categories** (see **R3—1,** 3.2(c)). The statement of the requirements with which the design complies should be in terms of the Approval Categories detailed in this paragraph 1.1.

1.1.1 **Approval Category Unrestricted.** Apparatus for which compliance with the requirements of **R3—2** is shown. Such apparatus is approved as being suitable for use irrespective of the weight of the aircraft in which it is installed.

NOTE: Such apparatus may normally be used under any circumstances of flight subject to any general or particular restrictions as specified in CAP 208.

1.1.2 **Approval Category LA Class 1.** Apparatus for which compliance with the requirements of **R3—3, 2** is shown. Such apparatus is approved as being suitable for use in aircraft the Maximum Weight of which is not greater than 5700 kg and in all circumstances of flight within or outside controlled airspace subject to any general or particular restrictions as specified in CAP 208, Vol. 2.

NOTE: Such apparatus is normally expected to possess electrical performance similar to apparatus in Category Unrestricted.

1.1.3 **Approval Category LA Class 2*.** Apparatus for which compliance with the requirements of **R3—3, 3** is shown. Such apparatus is approved as being suitable for use in aircraft the Maximum Weight of which is not greater than 5700 kg in circumstances of flight within controlled airspace under VFR, special VFR, or special entry/exit lane procedures, and outside controlled airspace under VFR or IFR, subject to any general or particular restrictions as specified in CAP 208, Vol. 2.

1.1.4 **Approval Category LA Class 3*.** Apparatus for which compliance with the requirements of **R3—3, 4** is shown. Such apparatus is approved as being suitable for use in aircraft the Maximum Weight of which is not greater than 5700 kg but may not be used to comply with a mandatory requirement for the mandatory carriage of radio equipment. Such apparatus is subject to any general or particular restrictions specified in CAP 208, Vol. 2.

1.1.5 **Approval Category G.** Apparatus for which compliance with the requirements of **R3—3, 5** is shown. Such apparatus is approved as being suitable for use in motorless aircraft, self launching or self-sustaining gliders.

1.2 **Associated Items** (see **R3—1,** 3.2(e)). The information should include at least the following, as appropriate.

(a) The output characteristics for supplying likely arrangements of other sub-systems.

(b) Any degradation in performance that could result when the receiver output is used to feed other apparatus.

(c) The accuracy achieved when the output of a receiver is fed to more than one synchro-operated device. This should be specified in terms of the number of synchro-receivers involved.

*Where such equipment is installed in an aircraft, compliance has to be shown with **R4—1,** 2.2.

(d) The characteristics of the control and indicating devices with which the device is declared to operate.

1.3 **Limiting Conditions** (see **R3—1,** 3.2(f)). Examples of information which may need to be provided for an item of apparatus are contained in (a) to (l).

(a) Supply voltage range (including ability to withstand transients).

(b) Supply frequency range.

(c) Duty cycle or time rating.

(d) Ambient temperature range (equipment unenergized).

(e) Ambient temperature range (equipment operating).

(f) Altitude rating.

(g) Climatic grade.

(h) Vibration grade, acceleration grade, explosion-proof category, fire resistance classification, magnetic interference (in terms of compass safe distance), and radio interference characteristics.

(j) Noxious fume risk.

(k) Mounting limitations.

(l) Any departures from governing specifications.

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SUB-SECTION R3—RADIO APPARATUS

CHAPTER R3—2 APPROVAL CATEGORY UNRESTRICTED

Revised, 10th April, 1974

1 GENERAL The requirements of this Chapter are applicable to Radio Apparatus for which Approval Category Unrestricted is sought.

NOTES: (1) Such apparatus is approved as being suitable for use irrespective of the weight of the aircraft in which it is installed.

(2) Requirements for apparatus for which a restricted approval category is sought are contained in **R3—3.**

2 OPERATIONAL CONDITIONS The Applicant shall declare those operational and environmental conditions in which,

(a) compliance is shown with the requirements of this Section appropriate to the category,

(b) the declared performance of the apparatus can be obtained, and

(c) the apparatus has been demonstrated as suitable for its intended purpose.

2.1 The declaration shall be made in terms of BS 3G.100 (or in terms of any other specification which is accepted by the CAA as specifying an acceptable standard) and shall include, as a minimum, declarations in respect of (a) to (d) together with declarations in respect of such other conditions as are appropriate to the apparatus (e.g. resistance to fire and explosion),

(a) humidity, temperature and pressure,

(b) vibration,

(c) acceleration,

(d) magnetic interference, in terms of compass safe distance.

3 DETAIL DESIGN

3.1 **Emergency Apparatus.** Equipment which the crew or passengers are expected to operate at the time of an emergency, shall be plainly marked as to its method of operation.

NOTE: For example, emergency radio beacons should be prominently marked externally with instructions for operation which are easily understood by an average passenger.

3.2 **High-powered Transmitters.** High-powered transmitters, aerials and associated equipment shall be so designed as to minimise the risk of flashover (see also **5**). The maximum voltage likely to be reached at the terminals of the transmitter, aerial and associated equipment under normal (including frequency changing) and Reasonably Probable fault conditions shall be declared.

NOTE: This information is necessary in order to enable compliance to be shown with the installation requirements of **R4—2.**

3.2.1 Apparatus shall be so designed that no damage to the apparatus will result from any maladjustment of controls or any likely changes in aerial characteristics (e.g. variations between aircraft). Account shall be taken of Reasonably Probable fault conditions in the aerial system or aerial equipment.

3.3 **Communication Transmitter-receivers.** The design of communication transmitter-receivers shall be such as to enable compliance to be shown with **R2—1,** 3.2 and 3.3.

3.4 **Controls.** The design of controls shall be such as to enable compliance to be shown with **R2—1,** 2.7 and 2.8.

4 FREQUENCY STABILITY AND INTERFERENCE

4.1 **Frequency Stability.** All radiation from Radio Apparatus shall conform to the current International Telecommunication Union Regulations* on the stability of the frequency of that radiation.

4.2 **Spurious Emissions.** The radiation from Radio Apparatus at frequencies other than the intended one shall not exceed those specified in the International Telecommunication Union Regulations*.

4.3 **Avoidance of Interference.** The design concept of Radio Apparatus shall be such that, when it is correctly installed in an aircraft, it will be unlikely that mutual interference between the apparatus and any other systems in the aircraft will be of an unacceptable nature.

NOTE: Acceptable limits for the emission of conducted and radiated interference are contained in BS 3G.100.

5 SAFETY PRECAUTIONS

5.1 **Shock and Burns.** Apparatus shall be so designed that in any foreseeable normal or fault conditions, the risk of dangerous electric shock or burning is reduced to an acceptable minimum (see also **Section J,** Chapter **J1—3**).

5.1.1 Connections shall be so arranged that parts liable to have potentials which could cause electric shock are not exposed to accidental contact.

5.1.2 Circuits connected to headsets or microphones shall be so designed as to avoid the risk of electric shock or build-up of static charges.

5.1.3 Insulation resistance between exposed metal parts and the windings, or other electrically connected elements, of a headset or microphone and associated connectors shall be in excess of 100 megohms when measured at 500 volts d.c. under normal atmospheric conditions as defined in BS 2011 "Methods for the Environmental Testing of Electronic Components and Electronic Equipment".

5.1.4 When apparatus is in operation the temperature of parts of the apparatus liable to accidental contact by crew members or other likely persons shall not exceed 80°C in the declared ambient temperatures.

5.2 **Fire and Explosion.** Apparatus shall be so designed that under any foreseeable normal conditions, fault conditions, or emergency operating conditions, it will not

(a) create a fire hazard,
(b) create hazardous quantities of noxious fumes,
(c) constitute a danger as the result of explosion.

NOTES: (1) It may be necessary to carry out tests in order to establish compliance with the requirements of this paragraph 5.2.
(2) See also **Section J,** Chapter **J1—3, 7.**

*Published by the General Secretariat of the International Telecommunication Union, Geneva.

5.2.1 Where sealed components are incorporated, or where apparatus is sealed, compliance shall be shown with either (a) or (b).

(a) In the event of—

(i) inadvertent over-pressurisation of the component or apparatus, or

(ii) the maximum differential pressure for the component or apparatus being exceeded,

an explosion will not occur.

(b) Explosion will not constitute a danger to the aircraft or the occupants.

5.2.2 Where a.c. power transformers and other devices containing wound coil assemblies are incorporated the relationship between—

(a) the peak transient loads associated with normal operation,

(b) the overload conditions at which the overload protective device is set to operate, and

(c) the confidence that can be placed in that protective device,

shall be such that in the event of overload conditions the risk of flames, fire or noxious fumes being generated is negligible.

5.3 **Radiation**

5.3.1 Where radiation from apparatus is such that it may be a hazard to health, the characteristics of that radiation shall be declared in the DDP.

5.3.2 Apparatus containing cathode-ray tubes shall either be so designed that there will be no danger to the aircraft or its occupants as a result of implosion or X-radiation, or the installation requirements necessary for the avoidance of such dangers be declared.

5.4 **Protective Devices.** Protective devices shall be so provided, and the associated circuits so designed, as to avoid hazard in the event of circuit failure.

5.4.1 The operation of a protective device shall not normally isolate from earth those parts of circuits which are usually so connected.

5.4.2 Protective devices shall be so rated that they do not cause disconnections under normal working conditions.

6 COMPASS SAFE DISTANCE The Compass Safe Distance for head-sets and for hand-held microphones shall be not greater than 30 cm (12 in) and 23 cm (9 in) respectively.

7 TESTS Tests shall be made to an acceptable specification to demonstrate that apparatus is suitable for, and will function correctly, in, those conditions for which it has been declared suitable in accordance with **2.** Where the Applicant has chosen to make the declarations in terms of BS 3G.100, the general provisions of this paragraph **7** shall be applicable. Where declarations are made in terms of other specifications, the general provisions governing tests shall be decided in consultation with the CAA.

NOTE: Further tests may be necessary for apparatus approval for any special conditions which may be encountered in the aircraft in which it may be installed.

7.1 **General.** The tests are concerned only with apparatus intended for general application. If the apparatus is designed for special operational conditions and its use is restricted to such conditions, the tests may be modified accordingly, by agreement with the CAA.

7.1.1 **Bench Tests.** Prototype apparatus shall be subjected to tests in accordance with the specification prepared by the Applicant, and to such other tests as may be required by the CAA, in order to determine its suitability for the purpose intended. It shall also be demonstrated that the apparatus complies with the appropriate Minimum Performance Requirements as specified in CAP 208.

7.1.2 **Flight Tests.** Where the conditions of flight have not been adequately simulated in the bench tests, tests under agreed conditions of flight shall be made to confirm the suitability of the apparatus.

7.1.3 **Acceleration Tests**

(a) In making tests, the equipment shall be secured to the test fixture by means of retaining devices essentially similar to those used on the aircraft.

(b) External cables, etc., shall be connected to the equipment for this test but the free ends may be fixed to the test fixture at any convenient position.

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SUB-SECTION R3—RADIO APPARATUS

CHAPTER R3—3 APPROVAL CATEGORY RESTRICTED

Revised, 10th April, 1974

1 GENERAL The requirements of this Chapter are applicable to Radio Apparatus for which approval in a restricted category is sought. Apparatus approved in accordance with this Chapter is approved for installation in aircraft the Maximum Weight of which does not exceed 5700 kg.

NOTE: Except for use of transmitters in gliders, apparatus approved in a higher approval category may be used for any application where apparatus approved in a lower approval category would be permitted.

1.1 **Operational Conditions.** The applicant shall declare those operational and environmental conditions in which,

(a) compliance is shown with the requirements of this Section appropriate to the Category in which approval is sought (e.g. LA Class 1, LA Class 2),

(b) the declared performance of the apparatus can be obtained, and

(c) the apparatus has been demonstrated as suitable for its intended purpose.

1.2 The declaration shall be made in terms of BS 3G.100 (or in terms of any other specification which is accepted by the CAA as specifying an acceptable standard) and shall include, as a minimum, declarations in respect of resistance to those conditions prescribed for the particular Category in which approval is sought, together with declarations in respect of such other conditions as are appropriate to the apparatus (e.g. resistance to fire and explosion).

2 APPROVAL CATEGORY LA CLASS 1 The requirements of this paragraph 2 are applicable to apparatus for which approval in Category LA Class 1 is sought.

2.1 **Performance.** The performance of apparatus approved in this category shall be adequate for the intended purpose.

NOTE: In general apparatus will have to comply with the appropriate minimum performance requirements specified in CAP 208, or with a similar equivalent specification. Where variations in detail in regard to individual clauses of the Specification are agreed, it will be necessary to demonstrate that the overall performance is adequate.

2.2 **Declaration.** The declaration prescribed in 1.2 shall include as a minimum declarations in respect of,

(a) humidity, temperature (see 2.3.2) and pressure,

(b) vibration,

(c) acceleration,

(d) magnetic interference, in terms of compass safe distance.

2.3 **Design and Construction**

2.3.1 The apparatus shall comply with the requirements for Detail Design of **R3—2, 3,** Frequency Stability and Interference of **R3—2, 4,** Safety Precautions of **R3—2, 5,** and Compass Safe Distance of **R3—2, 6.**

2.3.2 The design of the apparatus shall be such that the requirements of this paragraph 2 are met over a temperature range of −10°C to +50°C.

2.3.3 For navigation apparatus an assessment shall be made of the risk of dangerously misleading information being given under fault conditions.

3 APPROVAL CATEGORY LA CLASS 2

The requirements of this paragraph 3 are applicable to apparatus for which approval in Category LA Class 2 is sought.

3.1 **Performance.** The performance of apparatus approved in this category shall be adequate for the intended purpose.

NOTE: In general apparatus will have to comply with the appropriate minimum performance requirements specified in CAP 208, or with a similar equivalent specification. Where variations in detail in regard to individual clauses of the Specification are agreed, it will be necessary to demonstrate that the overall performance is adequate.

3.2 **Declaration.** The declaration prescribed in 1.2 shall include as a minimum declarations in respect of,

(a) temperature,

(b) vibration,

(c) magnetic interference, in terms of compass safe distance.

3.3 **Design and Construction**

3.3.1 The apparatus shall be inherently safe and comply with the requirements for Frequency Stability and Spurious Emissions of **R3—2,** 4.1 and 4.2.

3.3.2 The design of the apparatus shall be such that the requirements of this paragraph 3 are met over a temperature range of −10°C to +50°C.

4 APPROVAL CATEGORY LA CLASS 3

4.1 **Declaration.** The declaration prescribed in 1.2 shall include as a minimum a declaration in respect of,

(a) temperature,

(b) magnetic interference, in terms of compass safe distance.

4.2 **Design and Construction**

4.2.1 The apparatus shall be inherently safe and shall comply with the requirements for Frequency Stability and Spurious Emissions of **R3—2,** 4.1 and 4.2.

4.2.2 The design of the apparatus shall be such that the requirements of this paragraph 4 are met over a temperature range of −10°C to +40°C.

5 APPROVAL CATEGORY G

5.1 **Declaration.** The declaration prescribed in 1.2 shall include as a minimum a declaration in respect of temperature.

5.2 **Design and Construction**

5.2.1 The apparatus shall be inherently safe and shall comply with the requirements for Frequency Stability and Spurious Emissions of **R3—2,** 4.1 and 4.2.

5.2.2 The design of the apparatus shall be such that the requirements of this paragraph **5** are met over a temperature range of −10°C to +40°C.

5.2.3 The design of the apparatus shall be such that, the carrier power supplied to a transmission line or aerial does not exceed 2 watts in any of the allocated channels in the VHF band, and 10 watts in the HF band.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—1 GENERAL

Revised, 10th April, 1974

1 INTRODUCTION

1.1 Sub-section R4 prescribes requirements relating to the design, installation and testing of the aircraft radio communication and radio navigation installations.

1.2 The requirements of this Chapter are of a general nature and are applicable to Sub-section R4 as a whole.

2 GENERAL

2.1 Equipment shall be suitable for use in the environmental conditions associated with its installed position when the aircraft is operated within the range of conditions expected in service.

NOTE: Requirements applicable to equipment in the position in which it is installed in the aircraft are contained in **R4—2.**

2.2 Where apparatus which has operational limitations is installed, compliance shall be shown with 2.2.1 or 2.2.2 as appropriate.

2.2.1 For apparatus in Approval Category LA Class 2 or 3, the apparatus shall be labelled accordingly, and a notice stating the operational limitations shall be displayed in the crew compartment.

2.2.2 For apparatus other than that in Approval Category LA Class 2 or 3, the limitations shall, as agreed in consultation with the CAA, be entered in the Flight Manual and, if necessary, be placarded.

NOTE: Typical examples of the application of this requirement are:—

(a) Additional radio apparatus (see 5).

(b) Where the characteristics of a system are such as to impose limitations on a particular item in the system.

2.3 Apparatus shall be of types which have been approved in accordance with the appropriate Sections of the Requirements.

3 ACCELERATIONS

3.1 The equipment and installation shall be of the Acceleration Class and Grade appropriate to the accelerations which may normally occur at the position at which the equipment is installed in the aircraft.

NOTE: BS 3G.100 gives appropriate strength and functional classes for this purpose.

3.2 Aircraft Radio Systems which are required to operate during and/or after an emergency alighting or crash, up to the prescribed severity shall be such that they are capable of withstanding the accelerations appropriate to these conditions (for aeroplanes see **Section D***).

NOTE: Equipment which, if it broke loose under these conditions, could either injure occupants or nullify any of the escape facilities provided is also the subject of requirements (for aeroplanes see **Section D***, Chapter **D3—8, 2**).

4 MANDATORY RADIO APPARATUS

4.1 Mandatory Radio Apparatus is defined as the radio apparatus fitted in order to comply with the Air Navigation Order.

4.2 It shall be established that installations incorporating Mandatory Radio Apparatus will adequately perform the functions prescribed.

NOTE: Requirements for ground and flight testing are contained in **R4—6.**

5 ADDITIONAL RADIO APPARATUS

Where apparatus additional to that fitted in order to comply with the A.N.O. is installed it shall be demonstrated that the apparatus as installed is neither a source of danger in itself, nor prejudicial to the proper functioning of any service essential to the safe operation of the aircraft, and does not in any way reduce the airworthiness of the aircraft to which it is fitted even in the event of its failure to function.

NOTES: (1) In accordance with the A.N.O., additional radio apparatus has also to be approved in accordance with 2.3, and constitutes part of the aircraft radio installation.

(2) Requirements for ground and flight testing are contained in **R4—6.**

*Section K for light aeroplanes, Section G for rotorcraft.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—2 INSTALLATION

Revised, 10th April, 1974

1 GENERAL

1.1 Equipment shall be so installed that, under all expected conditions of operation, the environmental and operating conditions to which the equipment will be subjected are within the limits for which the equipment has been declared to be suitable.

NOTES: (1) Account should be taken of ventilation and cooling needs at an early stage of the design.
(2) Account should be taken of the relevant general requirements contained in that Section of the Requirements which is applicable to the aircraft, e.g. in **Section D,** Chapter **D3—8** for emergency alighting conditions, Chapter **D4—3** for access to exits, and Chapter **D6—8** for change of compass deviation.

1.2 Means of identification shall be provided, which shall be durable and adequate, to assist in the inspection of cables and in the testing of apparatus and circuits.

2 PROTECTION AGAINST MECHANICAL DAMAGE, DETERIORATION, FIRE AND EXPLOSION Equipment (including its associated wiring) shall be so installed as to comply with the requirements of **Section J,** Chapter **J1—3, 4, 5** and **7.**

NOTE: Account should be taken of ventilation and cooling needs when panels and bulkheads are provided for the mechanical protection of equipment.

3 ELECTRICAL PROTECTION

3.1 Conductors and terminals shall comply with the requirements of **Section J,** Chapter **J1—3, 6.**

3.2 The earth terminals of equipment or any exposed parts of metal or other conducting materials which are not connected thereto, shall be directly connected to the aircraft bonding system. Bonding shall comply with the requirements of **Section D,** Chapter **D4—6*** and earthing with **Section J,** Chapter **J3—3, 5.**

NOTES: (1) It is not necessary to bond exposed metal parts of headsets and microphones or small fixing devices such as screws.
(2) See also **R4—5** for other requirements for bonding.

4 COOLING The requirements of this paragraph **4** are applicable to cooling and ventilating systems.

NOTE: Particular care should be taken to ensure that:—
(a) Apparatus employing convection or forced air cooling is not installed in positions where air flow may be restricted by accumulations of foreign matter.
(b) The flow of air to equipment cannot be impeded (e.g. by freight or loose objects).

4.1 The air supply to forced-ventilated apparatus shall be derived from a region which cannot be contaminated by flammable liquids or vapours.

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*Section K, Chapter K4—6 for light aeroplanes.

4.2 Where the failure of a forced-air cooling system external to apparatus would result in a hazardous condition, or in the imminent failure of the apparatus served, the following shall be provided:—

(a) For Essential Services, a warning of failure of the cooling system, together with a standby cooling system.

NOTE: "Essential Services" are defined in the appropriate Section of the Requirements, for aeroplanes see **Section D**, Chapter **D1—2***.

(b) For other equipment a warning of failure of the cooling system.

5 CABLES AND WIRING

Cables and wiring forming part of the radio installation shall, in addition to compliance with this paragraph **5**, also comply with those requirements of **Section J**, Chapters **J3—2, J3—3** and **J4—1** which are applicable to the characteristics of the cables and their installation, and to the avoidance of interference.

NOTE: See also **R4—3, 1** for requirements for power supply cables.

5.1 Cables and wiring shall be such as to ensure adequate voltage insulation and current carrying capacity under all normal operational conditions, and under conditions of overvoltage and overcurrent which may arise from any likely maladjustment of the equipment.

5.2 Cables and wiring shall be so arranged that mutual interference between radio equipment, or between radio and electrical equipment, as a result of unintentional coupling between the wires and cables, is reduced to a level compatible with the performance characteristics of the systems.

6 OPERATION AND CONTROL

6.1 All controls, switches and indicators shall be so positioned that they can be operated and viewed by the appropriate member of the flight crew without causing undue strain or fatigue, and, where necessary to prevent the possibility of confusion, they shall be provided with a durable means of identification of their function.

NOTE: Reference should also be made to the appropriate Section for requirements for controls and instruments (for aeroplanes see **Section D**, Chapter **D4—8** and **D6—1**).*

6.1.1 The device provided to bring communication transmitters into the transmit mode shall be so designed that it cannot inadvertently be left in the transmission position (see also 6.3.1).

6.1.2 The vibration characteristics of any associated instrument panel shall be such as to not impair the accuracy of radio indicators, or to cause damage to them.

6.1.3 Indicators (e.g. calibrated dials) shall be so located that they are not subject to significant parallax error when viewed from the normal operating position.

6.1.4 All controls which are not under the direct surveillance of the flight crew shall be out of reach of passengers when they are occupying the accommodation provided for them.

NOTE: The provision of covers and guards is an acceptable method of complying with this requirement.

***Section K** for light aeroplanes, **Section G** for rotorcraft.

6.1.5 Where a channel selector does not display the frequency selected, and where the operational environment makes such information necessary, it shall be provided, within view of the appropriate flight crew member, by other means.

6.1.6 ILS instrument presentation shall be such that glide path information is presented only with the paired localiser information.

6.2 Adequate illumination shall be provided to facilitate the use of all controls, indicators, and associated maps and charts. Lights for such illumination shall be so installed that the eyes of the flight crew are not subjected to the direct rays, and that no objectionable reflections are visible to them.

NOTE: Where night shields are fitted they should be so designed that the lights will not be inadvertently obscured.

6.3 **Transport Category Aircraft.** The requirements of this paragraph 6.3 are applicable only to aircraft in the Transport Category.

6.3.1 Provision shall be made, at each pilot's station in the aircraft, for communication transmitters and the intercommunication system, where provided, to be brought into the transmission or intercommunication mode in accordance with (a) or (b) as appropriate. Any device making such provision shall be so designed that it cannot inadvertently be left in the transmission position, and shall be such that it will remain ON when moved to the intercommunication position.

(a) For turbo-jet aircraft where the minimum crew is not more than two, and for all aircraft below 5700 kg, the requirement may be met in accordance with either (i) or (ii).

(i) By a device, controlling both communication and intercommunication, fitted to the control column.

(ii) By a device controlling transmission on the control column, and a conveniently located separate device for controlling intercommunication.

(b) For aircraft, other than those described in (a), the requirement shall be met by a device, controlling both communication and intercommunication, fitted to the control column.

NOTE: The Air Navigation Order requires that aircraft engaged on flights for the purpose of public transport, the flight crew of which consists of more than one person, be provided with an intercommunication system for use by all members of the flight crew.

6.3.2 Provision shall be made for the use of non-hand-held microphones for use by the pilots and the flight engineer (if any).

6.3.3 Where an intercommunication system is provided, it shall be so installed that it is immediately available for use by all members of the flight crew at all times, without the need for them to move from their respective stations. The design of the system shall normally be such that, in order to address members of the flight crew, a pilot will not have to operate any device other than that provided in accordance with 6.3.1.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—3 POWER SUPPLIES AND CIRCUIT PROTECTION

Revised, 10th April, 1974

1 POWER SUPPLIES

1.1 Radio equipment shall be provided with electrical power supplies the characteristics of which are necessary for the normal functioning of the equipment.

1.2 The characteristics of the cables, from the aircraft distribution point to the input of each item of radio equipment, shall be such as to meet the input supply requirements of the radio units.

NOTE: In general a voltage drop not greater than that specified in (a) (b) or (c), as appropriate, would be acceptable:—

(a) 0·5V for an unregulated d.c. supply,

(b) 0·3V for a regulated d.c. supply, and

(c) 1·0% of the nominal voltage for an a.c. supply.

1.3 The power supplies for Mandatory Radio Apparatus shall be so arranged that, following the likely failure of any of its sources of power supply, such apparatus as will permit continued operation of the aircraft at an acceptable level of safety will continue to be supplied with power. For each source of supply, a supply failure warning device shall be provided.

NOTES: (1) General requirements relating to the carriage of Mandatory Equipment are contained in **Section D***, Chapter **D6—1.**

(2) Requirements affecting the reliability of electrical power supplies are contained in **Section J,** Chapter **J2—1, 2.**

1.4 Where automatic load-shedding would result in the termination of power supplies to items of radio equipment, information shall be provided detailing the services which would still receive a power supply and the procedures to be adopted to regain the services for which power supplies have been automatically terminated.

2 CIRCUIT PROTECTION

2.1 The circuits of the aircraft radio installation shall be suitably protected. The protection provided shall comply with the requirements of **Section J,** Chapter **J2—3, 4.**

NOTE: For the purposes of this paragraph **2** references to Mandatory Radio Apparatus should be taken as the equivalent of "Classified equipment" in **Section J,** and Additional Radio Equipment as the equivalent of "Unclassified equipment".

2.2 The operation of protective devices shall not isolate from earth parts of the circuit which are normally connected thereto. In aircraft the electrical distribution system of which is insulated on both poles, protective devices shall be incorporated in both the positive and negative supply leads; there shall be no fuse in the earth lead.

2.3 Those protective devices which may need to be replaced in flight (e.g. fuses) shall be installed in positions accessible to the flight crew.

NOTES: (1) In general this requirement will apply only to that Mandatory Radio Apparatus which is not effectively duplicated.

(2) Where Mandatory Radio Apparatus incorporates built-in supply fuses which are not accessible in flight, separate supply fuses will have to be provided in an accessible position, and the inaccessible fuses will have to be short circuited and labelled accordingly.

*Section K for light aeroplanes, Section G for rotorcraft.

2.4 Those protective devices which may need to be operated in flight (e.g. circuit breakers) shall be installed in a position as near as practical to the distribution point and shall be accessible to the flight crew.

NOTE: Any extension of the distribution point should be kept to a minimum and would have to comply with the general installation requirements.

2.5 Means shall be provided for identifying the protective device of each circuit.

2.5.1 Where the protective device is a fuse, the type and rating shall also be displayed independently of the fuse itself.

2.6 Spare electrical fuses shall be provided in accordance with **Section D***, Chapter **D6—1.**

*Section K for light aeroplanes, Section G for rotorcraft.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—4 AERIAL SYSTEMS

Revised, 10th April, 1974

I GENERAL Each aerial in the aerial system of the aircraft shall be designed, located and installed so as to ensure that, throughout the operational environment of the aircraft,

(a) the efficiency of the aerials is maintained at an acceptable level, in all reasonably expected conditions of operation (e.g. variations between aircraft and equipment, mishandling, maladjustment),

(b) electrical interference between aerials and between aerials and equipment is not such as to reduce the performance of any system below the required level,

(c) mechanical interference between aerials, or with any part of the structure, cannot occur,

(d) in the event of breakage of an aerial, there will be no danger to the aircraft.

NOTES: (1) Particular care should be taken to ensure that aerials are so located that their breakage will not cause:—
(a) interference with aircraft controls or engines,
(b) damage to the windscreen or the crew compartment windows.

(2) Particular attention should be given to the reduction of interference by static electricity and corona discharge. (See **R4—7**).

(3) See **R4—5** for protection against lightning strikes.

(4) See **R4—6** for the preparation of radiation patterns.

(5) Where aerials are installed on undersurfaces, it is recommended that measures be taken, where necessary, to reduce the risk of injury to personnel.

1.1 Electrical connections, radomes, and aerials suppressed in, and electrical connections for aerials mounted on, the undersurface of the fuselage or wing, shall be so protected as to avoid loss of efficiency as a result of the presence of liquids likely to be encountered.

1.2 Fixed wire aerials shall be physically independent of one another.

NOTE: No such aerial can be suspended from another such aerial or its cable outhaul.

1.3 Where a fixed wire aerial is such that the effects of differential movement between the aircraft and aerial could constitute a danger (e.g. flexing of the aircraft resulting in the aerial load being such as to damage the aircraft structure at an aerial attachment point) a tensioning device shall be provided.

1.4 For fixed wire aerials and for trailing aerials, the strength of the wires and components shall be such that, in conditions of excessive strain, a breakage will occur before damage is caused to the structure in the region of the aerial attachment point.

1.4.1 For fixed wire aerials it shall be shown that there will be no danger to the aircraft in the event of breakage,

(a) at any point, or

(b) at the after end, in which case the aerial and components shall be so arranged that any breakage will occur at the after end.

NOTES: (1) The provision of a weak link is the normal method of meeting this requirement.

(2) Where wire aerials are employed on pressurised aircraft, it is desirable to provide support of the aerial after failure of the weak link, in the form of a second weak link, to prevent damage to the pressure compartment by the loose end.

2 INSTALLATION

2.1 Joints in external wires or cables forming part of the aerial system shall be made by such methods as will not cause deterioration of the electrical or mechanical properties of the wires or cables.

2.2 The cable (other than a co-axial cable) forming that part of the aerial from the lead-in insulator to the transmitting unit, shall be separated from the metal structure of the airframe by a distance sufficient to prevent electrical breakdown even in the event of deterioration of the cable insulation.

2.3 Waveguides shall be supported so as to prevent chafing and excessive vibration, and shall be so located or protected that they are not liable to be damaged by baggage, freight or personnel. Waveguide systems shall be so designed and installed that contamination by moisture or any other foreign matter is reduced to a minimum.

2.4 All aerial feeders, and in particular those connected to HF aerials, shall be installed in such a manner as to ensure that a minimum of radio frequency energy is radiated inside the aircraft.

NOTE: Unless the level of radio frequency energy is effectively reduced it may be necessary to suppress the interference at the instruments and systems which are affected.

3 TRAILING AERIALS

3.1 Trailing aerial weights shall be so designed as to minimise the risk of:—

(a) Breakage or detachment under all aircraft operational conditions.

(b) Injury or damage to persons or property, in the event of the weights becoming detached.

NOTE: A collection of small beads is normally acceptable as a means of complying with this requirement.

3.2 Aerial winches shall be so designed and installed that:—

(a) The aerial cannot run out at a speed which could result in the breakage of any part of the winch or aerial.

(b) The cable drum can be locked when the aerial is fully wound in.

(c) There is a means of indicating that the cable drum is locked.

(d) On manual systems, there is an indication of the direction in which the drum should be rotated to wind in the aerial. The indication shall be visible in all conditions of winch operation.

(e) On remotely controlled systems, any overspilling from the aerial cable drum cannot cause interference with the aircraft control system or with exposed cables and equipment.

4 FLIGHT IN ICING CONDITIONS

In addition to compliance with **1** to **3**, aircraft for which clearance for flight in ice-forming conditions is sought shall comply with the requirements of this paragraph **4.**

4.1 Aerial systems shall be so installed or protected that the risk of breakage or interference with their performance, as a result of ice accretion, is reduced to an acceptable minimum.

4.2 Whip aerials shall be so designed and mounted as to minimise the possibility of breakage arising from flutter as a result of ice accretion.

NOTE: Normally a whip aerial of less than 940 mm (37 in) length would have to be flexibly mounted.

4.3 Aerials shall be positioned so that any ice that may form on them is not likely:—

(a) to enter engine intakes in sufficient quantities to cause engine malfunctioning,

(b) to enter into or to affect any system providing an Essential Service in such a manner as to interfere with the satisfactory operation of that service.

NOTE: "Essential Services" are defined in the appropriate Section of the Requirements, e.g. **Section D**, Chapter **D1—2** for aeroplanes.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—5 BONDING AND LIGHTNING DISCHARGE PROTECTION

Revised, 10th April, 1974

1 GENERAL The radio installation (including the aerial system) shall be so bonded and protected that the risk of serious damage to the aircraft or its occupants, as a result of lightning discharges or the accumulation of electrostatic charges, is reduced to a minimum. Bonding so provided shall comply with **Section D,** Chapter **D4—6***.

2 AERIALS

2.1 Any aerial which is vulnerable to lightning discharges shall incorporate a permanent lightning-discharge path such as to ensure that any damage resulting from a lightning discharge will be limited to the equipment connected directly to the aerial. Any protective devices provided shall be such as not to be actuated by normal operation of the associated transmitter.

2.2 Earthing connections to the airframe or aircraft bonding system shall be such that the possibility of arcing is reduced to a minimum.

NOTE: Connections should be close to the point of entry of the aerial, and sharp bends should be avoided.

2.3 In order to reduce danger of shock as a result of the accumulation of electrostatic charges on aerials, there shall be a permanent conducting path of not more than 6 megohms resistance between each aerial and the airframe or aircraft bonding system.

NOTE: Where a resistor is used to dissipate electrostatic charges it should be capable of withstanding the peak r.f. voltage developed by any transmitter associated with the aerial.

2.4 Where damage to aerial covers (e.g. radomes) by lightning discharges could endanger the aircraft, they shall be protected against lightning discharges. The means provided for protection shall be such as not to significantly reduce the performance of the aerial.

2.5 Where an aerial has a metal base to which the outer conductor of a coaxial cable is connected, the mounting arrangements shall be such as to provide a connection of low r.f. impedance between the base and the airframe.

*Section K for light aeroplanes, Section G for rotorcraft.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—6 GROUND AND FLIGHT TESTS

Revised, 10*th April,* 1974

1 INTRODUCTION (see R4—6 App. No. 1, 1)

1.1 For some of the requirements prescribed in Sub-section R4 "Aircraft Radio Installations" (e.g. those connected with environmental suitability, compatibility, adequate performance of function) it will be necessary to conduct tests in order to provide confirmation of compliance. This Chapter **R4–6** and its Appendices contain requirements and interpretative material appropriate to such tests.

1.2 The presentation is such that acceptable means of showing compliance with the requirements of 2 are detailed in the Appendices to this Chapter **R4–6**. Appendix No. 1 contains material appropriate to all ground and flight testing, together with details of tests generally applicable to all equipment (both Mandatory and Additional alike). The subsequent Appendices contain material appropriate to the testing of specific systems (e.g. VHF, ADF). Thus the approval of the Aircraft Radio Installation will involve the provisions of Appendix No. 1 and the provisions of the Appendices appropriate to the systems incorporated in the Installation.

2 GENERAL (see R4—6 App. No. 1, 2) Ground and flight tests, as appropriate, shall be made to establish:—

(a) That equipment functions correctly and safely as installed in the aircraft.

NOTE: It is necessary, amongst other things, to ensure that the installation accords with declarations made in DDP's.

(b) That equipment is properly co-ordinated*.

NOTE: This requirement is intended to cover such matters as receiver loading, cross switching, cooling, etc.

(c) That where items of equipment are intended to be operated simultaneously, the level of radio and electrical interference from any such items is not such as to reduce the performance of the other items by an unacceptable amount*.

(d) That systems perform to the Standards prescribed in the Minimum Operational Performance Requirements.

*Although units, accessories, fittings cables and aerials may be of Approved types, it does not necessarily follow that they will be suitable for use with associated units.

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APPENDIX NO. 1 TO CHAPTER R4—6

Issued, 10*th April,* 1974

TESTS—GENERAL

1 INTRODUCTION (see R4—6, 1) This Appendix contains details of an acceptable method by which compliance may be shown with the requirements of **R4–6.**

2 GENERAL (see R4—6, 2)

2.1 **Test Schedule.** A schedule of ground and flight tests should be prepared by the Applicant, in accordance with 2.1.1 or 2.1.2 as appropriate, for agreement by the CAA. Test results should be submitted to the CAA, and should be such as to show compliance with **R4–6, 2.**

2.1.1 **Mandatory Radio Apparatus.** For Mandatory Radio Apparatus, the tests should be conducted in accordance with the general provisions, and should include the general tests of this Appendix No. 1, together with at least the tests detailed in the Appendix appropriate to the equipment (e.g. Appendix No. 2 for VHF communication systems).

2.1.2 **Additional Radio Apparatus.** For Additional Radio Apparatus the tests should be conducted in accordance with the general provisions, and should include the general tests of this Appendix No. 1, together with such other tests as are considered necessary for the particular item.

2.2 **Ground Stations.** Where radio navigational aids are required to be tested in conjunction with a ground station, the station should be one of known performance.

2.3 **Effective Radio Horizon.** An acceptable method for the calculation of Effective Radio Horizon, assuming a radius $\frac{1}{3}$ greater than earth radius, is as follows:—

$$\text{Effective Radio Horizon (n miles)} = 1{\cdot}23\sqrt{H_1} + 1{\cdot}23\sqrt{H_2}$$

where H_1 . . . feet . . . is height of ground station above sea-level,

H_2 . . . feet . . . is height of aircraft above sea-level.

To calculate in kilometres with heights in metres the factor of 1·23 becomes 4·12 in both cases.

NOTE: Civil Aviation Radio Measuring Station Pailton aerial is 152·4 m (500 ft) above sea-level.

2.4 **Range.** Normally the operation of a flag or similar warning device will be an acceptable means of indicating range.

2.5 **Performance.** Prior to the commencement of ground and flight tests the performance of all equipment should be established and recorded.

3 AIRCRAFT ATTITUDES Where in showing compliance, system performance has to be checked over the range of normal aircraft attitudes, it is acceptable to conduct investigations at practical combinations of bank, pitch and aircraft heading at reasonably spaced increments. The most adverse logical combination of any two about the other one should be included.

4 AERIALS Tests should be completed to establish:—

(a) an acceptable location of aerials, and

(b) that the performance of each aerial and its associated equipment is at an acceptable level.

4.1 For each aerial (other than radar and low frequency aerials) a radiation pattern for frequencies at the centre and at each end of the frequency range appropriate to the equipment should be established.

NOTES: (1) Normally radar and low frequency aerials can only be proven in the course of the flight tests prescribed for the associated equipment.

(2) For aeroplanes the Maximum Weight of which is not greater than 5700 kg (12,500 lb) a radiation pattern need not be established for the ILS glide path aerial (but see **R4—6** App. No. 4, 3.2.2.).

4.2 Radiation patterns may be established on the aircraft or with the use of models.

4.2.1 Where the aircraft is used, the radiation patterns may be established either in flight or on the ground, except for aerials mounted on the undersurface of the aircraft where ground clearance is critical, in which case the patterns should be established in flight.

4.2.2 For radiation patterns obtained from both aircraft and model tests alike, aircraft flight testing should be done to such an extent as to substantiate the radiation patterns over the entire range. Critical areas, in particular, should be the subject of further investigation.

4.3 Where any change is made to the location of an aerial, or fittings in or on the aircraft, or to the method of installation, the effect on the radiation pattern for the affected aerial, together with the radiation patterns for the other aerials, should be considered and, where necessary, new patterns should be established.

5 GROUND TESTS

5.1 The equipment should be submitted to the tests included in this paragraph **5**, and where appropriate, aerial circuits and components should be examined for arcing and damage.

NOTE: Items of equipment are not normally opened up for examination unless there is some external indication that could call for investigation.

5.1.1 Before the commencement of ground tests it should be ensured that items which could affect the continuity of the aircraft bonding, e.g. hatches, are correctly in position.

5.2 Electrical power should be applied at the same time to all circuits, units and components, and where practical, for the particular system, operational checks should be carried out using appropriate test equipment. The characteristics of the electrical power supplies used for the tests should be within the limits provided in the aircraft in accordance with **R4–3**, 1.1.

5.2.1 Transmitters should be connected in turn to each aerial that is intended to be connected to them, and should be operated at full power. Correct aerial matching should be established by testing at various frequencies, widely separated in the frequency range covered by the transmitter, one of which should be the lowest possible.

5.2.2 With the aircraft engines running, and with all electrical equipment which can be operated on the ground in operation, all aircraft radio systems should be operated over a range of frequencies such as to establish that the level of radio and electrical interference is such as not to reduce the performance of any system below a level compatible with the characteristic performance of that system.

NOTES: (1) Where certification is sought for landing in restricted visibility the level of VHF/ILS interference is of great importance.

(2) Recommended acceptable levels of interference are contained in BS Code of Practice CP.1012 'The Abatement and Measurement of Radio Interference from Electrical Installations in Civil Aircraft'.

6 FLIGHT TESTS

6.1 Before the commencement of flight tests the aircraft radio installation should be essentially complete.

6.2 Transmitters should be connected in turn to each aerial to which they are intended to be connected, and should be operated at full power at various frequencies, widely separated in the frequency range covered by the transmitter, one of which should be the lowest possible. Where altitude can have an adverse effect on performance, the altitude should be as near as possible to the maximum permissible altitude. There should be no evidence of malfunctioning or deterioration of equipment.

6.3 With all electrical equipment which can be operated in flight in operation, receiving and navigational equipment, and approach and landing aids should be operated over a range of frequencies such as to establish that the level of radio and electrical interference is such as not to reduce the performance of any system below a level compatible with the characteristic performance of that system.

NOTES: (1) Pilot assessment will normally be acceptable.

(2) Recommended acceptable levels of interference are contained in BS Code of Practice CP.1012 'The Abatement and Measurement of Radio Interference from Electrical Installations in Civil Aircraft'.

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APPENDIX NO. 2 TO CHAPTER R4—6

Issued, 10th April, 1974

TESTS FOR VHF COMMUNICATION SYSTEMS

1 INTRODUCTION The tests detailed in this Appendix No. 2, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6**, in respect of VHF communication systems.

2 GROUND TESTS The equipment should be submitted to the tests of this paragraph **2**, prior to flight testing, at the frequency at which it is proposed to conduct the flight tests.

2.1 With a known muting level, determine the sensitivity of each communications receiver.

NOTE: This test is not normally conducted on the aircraft.

2.2 Measure the incident and reflected power of each transmitter and its associated coaxial feeder:—

(a) at the transmitter end of the feeder, and

(b) at the aerial end of the feeder.

2.3 Using the information obtained in accordance with 2.2 ensure that the feeder losses are within acceptable limits.

NOTE: Where it is desired to establish Effective Radiated Power it may be taken as the output power at the transmitter terminal, minus feeder and mismatch losses, plus average aerial gain relative to an isotropic radiator in the horizontal direction, or:—

$$ERP = P_T - L + G_A$$

where ERP ..... dbW ..... is power in decibels (db) relative to 1 watt (W),
P_T ..... dbW ..... is transmitter power,
L ..... db ..... is feeder and mismatch losses,
G_A ..... db ..... is aerial gain.

3 FLIGHT TESTS The equipment should be subjected to the tests of 3.2 in the conditions of 3.1.

3.1 **Test Conditions.** The tests should be conducted in accordance with (a) or (b) as appropriate:—

(a) Where the normal cruising altitude is not greater than 6100 m (20,000 ft)—at the normal cruising altitude.

(b) Where the normal cruising altitude is greater than 6100 m (20,000 ft)—at an altitude of not less than 6100 m (20,000 ft).

3.2 **Tests**

3.2.1 Establish the maximum communication ranges by flying towards and away from an Approved ground station* (i.e. relative bearings of 000° and 180°).

3.2.2 At a distance of not less than 80% of the Effective Radio Horizon execute orbits about a fixed point, level the aircraft every 10°, and determine those sectors where:—

(a) communication is maintained,

(b) communication is not maintained.

For those sectors where:—

(i) communication is maintained, establish that it is maintained over angular sectors of ±30° fore and aft, relative to the aircraft centre line,

(ii) communication is not maintained, establish
—the angular width of each sector,
—that the distance at which communication is maintained is not less than 65% of the Effective Radio Horizon.

3.2.3 At a range of not less than 60% of the Effective Radio Horizon, establish that communication can be maintained when flying towards and away from the Approved ground station in the following conditions:—

(a) at all attitudes used in normal climb and descent,

(b) at all banked attitudes used in cruising flight.

*C.A.R.M.S. Pailton is an Approved ground station.

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APPENDIX NO. 3 TO CHAPTER R4—6

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TESTS FOR ADF SYSTEMS

1 INTRODUCTION The tests detailed in this Appendix No. 3, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of R4—6, in respect of ADF systems.

2 GROUND TESTS Prior to determination of quadrantal error, the tests of this paragraph 2 should be carried out in the order stated.

2.1 General

2.1.1 The tests should be carried out with the aircraft positioned as far as practical from hangars, buildings, aerial masts, and any sources of electrical noise.

2.1.2 The capacitance of aerial systems should be measured at a frequency in the region of 200 KHz.

NOTES: (1) In the U.K. it is advisable to measure at a frequency greater than 200 KHz, so as to avoid interference from the Droitwich 200 KHz Broadcast Transmitter.

(2) The use of 1 KHz capacitance meters is not recommended as they are liable to give incorrect values.

2.2 Aerial System

2.2.1 Check that the loop aerial fore and aft datum line is correctly aligned with, or parallel to, the fore and aft centre line of the aircraft.

NOTE: Acceptable procedures for elimination of loop alignment error are contained in CAIP Leaflet RL/2—1*.

2.2.2 With the connecting cable disconnected from the sense aerial, check that the capacitance of the aerial to the aircraft is within the design limits.

2.2.3 Where aerial coupling units are fitted:—

(a) check that they are the correct type for the aircraft, and

(b) that the input capacitance to the coupling unit is of the correct value.

2.2.4 Measure the total capacitance of the sense aerial and feeder system at the receiver, and

(a) check that it is of the correct value for the associated receiver,

(b) where provision is made for adjusting this capacitance, ensure that the capacitance is suitably adjusted.

3 DETERMINATION OF QUADRANTAL ERROR Quadrantal error should be determined by loop swinging.

NOTE: Acceptable procedures are contained in CAIP Leaflet RL/2—1*.

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*Civil Airworthiness Inspection Procedures published by the Civil Aviation Authority.

3.1 **General**

3.1.1 Determination of quadrantal error (loop swinging) may be carried out on the ground or in flight.

NOTE: It is strongly recommended that loop swinging be conducted on the ground, where precise positioning of the aircraft and more accurate readings of the bearing indicator are possible. However, where loop or sense aerials are mounted beneath the aircraft, and are appreciably affected by the proximity of the ground, or by parts of aircraft in the landing configuration (e.g. in the case of large aircraft) loop swinging will normally have to be carried out in flight.

3.1.2 Loop swinging should only be carried out in the period of time between 2 hours after sunrise and 2 hours before sunset.

NOTE: These restrictions on time are necessary to avoid night effect, resulting from variations of the ionosphere.

3.2 **Ground Loop Swinging.** When quadrantal error is determined on the ground:—

(a) the area or base on which the swinging is to be carried out should have been fully surveyed, both electrically and magnetically, and should have been approved for this purpose, and

(b) the radio bearings of the stations to be used for the swinging should have been determined.

3.3 **Flight Loop Swinging.** Where quadrantal error is determined in flight, the location employed for the loop swinging should be as far as possible from the radio station used, consistent with obtaining a steady bearing and, if possible, should be not less than 50 n miles (93 km).

4 CORRECTION OF QUADRANTAL ERROR Corrections, sufficient to reduce the quadrantal error determined in accordance with **3** to an acceptable level, should be applied to the system.

5 SYSTEM PERFORMANCE Where quadrantal error has been determined on the ground, the tests of (a) and (b) should be carried out on a site known to be free from electrical noise, and for which the radio bearings and signal strengths of suitable radio stations providing weak signals have been determined:—

(a) Tune to a selected station and check that the station can be clearly identified.

(b) Check that the bearing indicator displays the station bearing with an acceptable degree of accuracy and 'hunting'.

NOTE: When an aircraft is equipped with a sense aerial mounted beneath the aircraft and fairly close to the ground, indicator activity on the ground could differ from that obtained in flight.

6 FLIGHT TESTS On completion of the procedures described in **2** to **5**, the following flight tests should be carried out.

(a) At a distance of not less than the declared service range of a ground station, establish that at the maximum quadrantal error points the displayed bearing is accurate to within $\pm 5°$, exclusive of compass error.

(b) Approach a ground station from a distance of not less than 20 n miles (37 km) at a height of between 1525 and 3048 m (5,000 and 10,000 ft). Flying over the ground station check that the reversal of the bearing pointer occurs within a circular area centred over the station the radius of which is equal to the altitude of the aircraft. Partial reversals, which may lead or lag the main reversal should be ignored during the tests.

(c) Repeat the test of (b) on the reciprocal bearing.

(d) At 150% of the declared service range of a ground station, check that the station can be clearly identified.

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APPENDIX NO. 4 TO CHAPTER R4—6

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TESTS FOR VOR, ILS AND MARKER SYSTEMS

1 INTRODUCTION The tests prescribed in this Appendix No. 4, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6** in respect of VOR, ILS and Marker Systems.

2 GROUND TESTS The equipment, i.e. VOR system, and ILS system (localiser, glide slope and marker) and En-route Marker should be submitted to the tests of this paragraph **2**, prior to flight testing.

2.1 **General**

2.1.1 The Voltage Standing Wave Ratio (VSWR) of the aircraft aerials and aerial systems, including co-axial feeders should be determined and recorded.

2.1.2 The attenuation resulting from the aircraft aerial co-axial feeders should be determined and recorded.

2.2 **VOR.** Establish that the displayed bearings are accurate to within $\pm 6°$, excluding compass error.

3 FLIGHT TESTS The equipment should be subjected to the tests of this paragraph **3**.

3.1 **VOR.** The tests should be conducted in accordance with (a) or (b) as appropriate:—

(a) Where the normal cruising altitude is not greater than 6100 m (20,000 ft)—at the normal cruising altitude.

(b) Where the normal cruising altitude is greater than 6100 m (20,000 ft)—at an altitude of not less than 6100 m (20,000 ft).

3.1.1 Establish:—

(a) That the maximum ranges when flying towards and away from the ground station (i.e. relative bearings of 000° and 180°) are not less than 80% of the Effective Radio Horizon.

(b) That at the ranges established in accordance with (a) the ground station is clearly identifiable.

3.1.2 At a distance of not less than 70% of the Effective Radio Horizon execute orbits about a fixed point, level the aircraft every 10°, and determine those sectors where:—

(a) a usable signal is received,

(b) a usable signal is not received.

For those Sectors where:—

(i) a usable signal is received, establish that it is received over angular sectors of $\pm 30°$ fore and aft, relative to the aircraft centre line,

(ii) a usable signal is not received, establish

—the angular width of each sector,

—that the distance at which a usable signal is received is not less than 60% of the Effective Radio Horizon.

3.1.3 At a distance of not less than 55% of the Effective Radio Horizon, establish that a reliable signal can be received when flying towards and away from the ground station in the following conditions:—

(a) at all attitudes used in normal climb and descent,

(b) at all banked attitudes used in cruising flight.

3.1.4 Set the omni-bearing selector to a known radial and whilst flying along the radial, change the selected course, so as to produce deflections of the lateral deviation indicator to half scale and to full scale, and check that the corrective indications are correctly related to the course change.

3.1.5 At a distance of not less than 50% of the Effective Radio Horizon, fly towards or away from the ground station at a constant altitude, apply 20° bank first to port and then to starboard, record the movement of the lateral deviation indicator, and establish that it is not greater than the movement corresponding to a course change of 3°.

NOTE: Where the permissible angle of bank is less than 20°, the test should be completed at the maximum permissible angle.

3.2 ILS System

3.2.1 Localiser

(a) Establish:—

(i) That the range is not less than 25 n miles (46 km), when flying towards the ground station at an altitude 610 m (2,000 ft) greater than the ground station, with the lateral deviation indicator centralised.

(ii) That at the range established in accordance with (i) the ground station is clearly identifiable.

(b) At an altitude 610 m (2,000 ft) greater than the ground station, at a distance of not less than 20 n miles (37 km) execute orbits about a fixed point, and determine those sectors where:—

(i) a usable signal is received,

(ii) a usable signal is not received.

For those Sectors where:—

(iii) a usable signal is received, establish that it is received over an angular sector of $\pm 80°$ forward, relative to the aircraft centre line,

(iv) a usable signal is not received, establish:—

—the angular width of each sector,

—the distance at which a usable signal is received.

(c) At a distance of not less than 15 n miles (28 km) establish that a reliable signal can be received when flying towards the ground station in the following conditions:—

(i) at all attitudes used in normal climb and descent,

(ii) at all banked attitudes used in cruising flight.

3.2.2 **Glide Path.** The tests should be carried out in accordance with (a) or (b), as appropriate.

(a) Where a radiation pattern has been established for the glide path aerial, establish that the range is not less than 10 n miles (18·5 km) when flying towards the ground station with the lateral deviation indicator centralised.

(b) Where a radiation pattern has not been established for the glide path aerial (see **R4—6** App. No. 1, 4.1):—

(i) Establish the maximum range when flying towards the ground station with the lateral deviation indicator centralised.

(ii) Carry out an approach in the conditions of (i) and at the onset of reliable signals:—

—Fly below the glide path so as to produce full scale deflection of the vertical deviation indicator.

—Fly above the glide path so as to produce full scale deflection of the vertical deviation indicator.

—Centralise the lateral and vertical deviation indicators. Turn through an angle of 45° to starboard so as to produce a full scale deflection on the lateral deviation indicator. Execute a turn to port so as to cross the localiser beam at right angles. Fly to port so as to produce a full scale deflection on the lateral deviation indicator. Execute a turn to starboard and centralise the lateral deviation indicator. Record any unusual movements of the vertical deviation indicator or operation of flags or similar warning devices.

3.2.3 **Marker.** Make a normal approach and record the length of time that the marker indicators are illuminated.

(a) Establish that the ratio between the ground speed and time is proportional to the following times which are appropriate to a ground speed of 178 km/h (96 knots) and low sensitivity setting.

(i) Outer $16 \text{ s} \pm 8 \text{ s}$

(ii) Middle $6 \text{ s} \pm 3 \text{ s}$

(iii) Inner $4 \text{ s} \pm 2 \text{ s}$

(b) Check that the marker audio tones are clearly audible.

3.2.4 **Complete System.** With all aircraft systems that would normally be in operation during an approach in operation, execute a minimum of 3 satisfactory standard ILS approaches (one from a range of 25 n miles (46 km)) and record:—

(a) any unusual movements of the lateral or vertical deviation indicators,

(b) any operation of flags or similar warning devices.

3.3 **En-route Marker Beacons.** Fly over a beacon (i.e. relative bearing of 000°) and record:—

(a) the length of time that the marker indications are presented,

(b) the altitude of the aircraft,

(c) the identity of the beacon.

NOTE: To be acceptable, the ratio between ground speed, altitude, and time of illumination should be reasonably proportional to the following:—

At a ground speed of 740 km/h (400 knots), at 6100 m (20,000 ft) the time of presentation is approximately 40 seconds.

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APPENDIX NO. 5 TO CHAPTER R4—6

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TESTS FOR WEATHER RADAR SYSTEMS

1 INTRODUCTION The tests prescribed in this Appendix No. 5, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6** in respect of Weather Radar Systems.

1.1 As the performance of the equipment cannot be established satisfactorily in natural cloud conditions (because of lack of data, e.g. droplet size, density) the tests, except for the tests of 3.2.5, are prescribed in terms of transmission to, and reflection from, the surface of the earth.

2 GROUND TESTS

2.1 The Voltage Standing Wave Ratio (VSWR) of the waveguide system, including scanner, should be determined and recorded with the aircraft radome in position.

2.2 The declared Performance Index for the equipment should be consistent with that established for the aircraft type.

3 FLIGHT TESTS

3.1 **Test Conditions**

3.1.1 Where tests are to be conducted during cruising flight the altitude should be chosen in accordance with (a) or (b) as appropriate:—

(a) Where the normal cruising altitude is not greater than 6100 m (20,000 ft)—at the normal cruising altitude.

(b) Where the normal cruising altitude is greater than 6100 m (20,000 ft)—at an altitude of not less than 6100 m (20,000 ft).

3.2 **Tests**

3.2.1 During cruising flight, determine and record the minimum and maximum ranges:—

(a) as applicable to each of the selectable ranges at optimum tilt angles,

(b) in all functions for which provision is made.

3.2.2 At a suitable low altitude, check that no unacceptable side lobes exist.

NOTE: Isolated targets such as remote islands and large ships are normally used.

3.2.3 Check performance of stabilisation systems during normal,

(a) climb,

(b) cruising flight,

(c) descent,

(d) turns,

and record any attitudes at which there is any significant loss of, or disturbance to, the display.

3.2.4 In straight level flight over suitable terrain, at the maximum downward tilt angle, check that the spurious returns are not at an unacceptable level.

3.2.5 Check that the system will detect and produce a satisfactory display from suitable cloud formations.

NOTE: Normally suitable conditions will be encountered sometime in the course of the aircraft flight test programme.

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APPENDIX NO. 6 TO CHAPTER R4—6

Issued, 10*th April,* 1974

TESTS FOR DISTANCE-MEASURING EQUIPMENT SYSTEMS

1 INTRODUCTION The tests detailed in this Appendix No. 6, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6**, in respect of Distance-measuring Equipment (DME) systems.

2 GROUND TESTS The equipment should be submitted to the tests of this paragraph **2**, prior to flight testing.

2.1 Measure the incident and reflected power of each transmitter and its associated coaxial feeder:—

(a) at the transmitter end of the feeder, and

(b) at the aerial end of the feeder.

2.2 Using the information obtained in accordance with 2.1, ensure that the feeder losses are within acceptable limits.

2.3 Establish that the displayed readings are accurate to within 0·5 n miles (0·9 km) or ±2% whichever is the greater.

3 FLIGHT TESTS The equipment should be subjected to the tests of 3.2 in the conditions of 3.1.

3.1 **Test Conditions**

3.1.1 The tests should be conducted in accordance with (a) or (b) as appropriate:—

(a) Where the normal cruising altitude is not greater than 6100 m (20,000 ft)—at the normal cruising altitude.

(b) Where the normal cruising altitude is greater than 6100 m (20,000 ft)—at an altitude of not less than 6100 m (20,000 ft).

3.1.2 During tests, the rate of turning, or the overfly period, should be so related to the memory period of the particular DME equipment, that at each angular point the full memory period has elapsed.

3.2 **Tests**

3.2.1 (a) Determine the maximum ranges when flying towards and away from the ground station (i.e. relative bearings of 000° and 180°) and establish that they are not less than 75% of the Effective Radio Horizon.

(b) Establish that at the ranges established in accordance with (a) the ground station is clearly identifiable.

3.2.2 At a distance of not less than 65% of the Effective Radio Horizon execute orbits about, or overfly, a fixed point, level the aircraft every 10° and determine those sectors where:—

(a) a usable signal is received,

(b) a usable signal is not received.

For those Sectors where:—

(i) a usable signal is received, establish that it is received over angular sectors of ±30° fore and aft, relative to the aircraft centre line*,

(ii) a usable signal is not received, establish:—

—the angular width of each sector,

—that the distance at which a usable signal is received is not less than 55% of the Effective Radio Horizon.

3.2.3 At a range of not less than 50% of the Effective Radio Horizon, establish that a reliable signal can be received when flying towards and away from the ground station in the following conditions:—

(a) at all attitudes used in normal climb and descent,

(b) at all banked attitudes used in cruising flight.

*Normally a reliable signal received at each 10° increment will be acceptable.

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APPENDIX NO. 7 TO CHAPTER R4—6

Issued, 10th April, 1974

TESTS FOR INTERCOMMUNICATION AND AUDIO-INTEGRATION SYSTEMS

1 INTRODUCTION The tests prescribed in this Appendix No. 7, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6, 2** in respect of Intercommunication and Audio-integration Systems*.

2 GROUND TESTS The Intercommunication and Audio-integration Systems should be submitted to the tests of this paragraph **2** prior to flight testing.

2.1 Establish that the various components of the system are satisfactorily matched (receiver loading, headset impedance, microphone outputs, etc.) and that the performance determined in accordance with **R4—6** App. No. 1, 2.5, is satisfactory in relation to the complete system.

NOTE: Account should be taken of the possible effects of the use of Public Address and Music Reproduction Systems.

2.1.1 The tests of 2.1 should be conducted either:—

(a) with engines running, or

(b) with ground power supplies, provided that the characteristics of the supplies with respect to interference are comparable with the characteristics of the supplies from the aircraft power installation.

2.1.2 A qualitative assessment should also be made at each crew position with the system in use:—

(a) in all modes of operation for which provision is made, and

(b) in conjunction with all associated systems, in order to demonstrate that the system functions satisfactorily.

2.2 With input signals of the normal working magnitude, establish, for each channel, that the ratio of wanted to unwanted audio output is not less than 45 db.

NOTES: (1) In addition to crosstalk and unintentional coupling, any other significant interference which could be present in the aircraft will have to be taken into account.

(2) An acceptable method is to take measurements under selected adverse logical combinations of operating conditions and standard input and output levels, with the headset disconnected and represented by an equivalent load.

2.3 Establish that the residual noise level is below -30 dbm in the absence of an audio input signal.

3 FLIGHT TESTS With all aircraft systems which can be operated in flight in operation, a qualitative assessment of both normal system performance, and performance following an occurrence which would impair the working of the system, should be made in order to demonstrate that the system functions satisfactorily.

3.1 Where microphones are installed in oxygen or smoke masks the assessment of **3** should be repeated with the mask in the operational condition.

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*For the purpose of this Appendix, a system in which radio communication and/or audible warnings are fed into an intercommunication system.

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APPENDIX NO. 8 TO CHAPTER R4—6

Issued, 10th April, 1974

TESTS FOR AIR TRAFFIC CONTROL TRANSPONDER SYSTEMS

1 INTRODUCTION The tests detailed in this Appendix No. 8, together with the general tests of Appendix No. 1, constitute an acceptable method of establishing compliance with the requirements of **R4—6**, in respect of Air Traffic Control Transponder systems operating on Mode A (Identification).

NOTE: The procedure for testing of Mode C (Altitude) should be decided in consultation with the CAA.

2 GROUND TESTS The equipment should be submitted to the tests of this paragraph **2**, prior to flight testing.

2.1 Measure the incident and reflected power of each transmitter and its associated coaxial feeder:—

(a) at the transmitter end of the feeder, and

(b) at the aerial end of the feeder.

2.2 Using the information obtained in accordance with 2.1, ensure that the feeder losses are within acceptable limits.

3 FLIGHT TESTS The equipment should be subjected to the tests of 3.2 in the conditions of 3.1.

3.1 **Test Conditions**

3.1.1 The tests should be conducted in accordance with (a) or (b) as appropriate:—

(a) Where the normal cruising altitude is not greater than 4575 m (15,000 ft)—at the normal cruising altitude.

(b) Where the normal cruising altitude is greater than 4575 m (15,000 ft)—at an altitude of not less than 4575 m (15,000 ft).

3.1.2 For the purpose of this Appendix a valid reply is considered to have been transmitted by the system in the aircraft when the signal strength is such as to result in an acceptable visual indication on the ground station equipment.

3.2 **Tests**

3.2.1 Determine the maximum ranges at which valid replies are transmitted when flying towards and away from the ground station (i.e. relative bearings of 000° and 180°) and establish that they are not less than 80% of the Effective Radio Horizon.

3.2.2 At a distance of not less than 60% of the Effective Radio Horizon execute orbits about, or overfly, a fixed point, level the aircraft every 10°, and determine those sectors where:—

(a) a valid reply is transmitted,

(b) a valid reply is not transmitted.

For those Sectors where:—

(i) a valid reply is transmitted, establish that it is transmitted over angular sectors of $\pm 20°$ fore and aft, relative to the aircraft centre line,

(ii) a valid reply is not transmitted, establish:—

—the angular width of each sector,

—that the distance at which a valid reply is transmitted is not less than 50% of the Effective Radio Horizon.

3.2.3 At a range of not less than 50% of the Effective Radio Horizon establish that a valid reply can be transmitted when flying towards and away from the ground station in the following conditions:—

(a) at all attitudes used in normal climb and descent,

(b) at all banked attitudes used in cruising flight.

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SUB-SECTION R4—AIRCRAFT RADIO INSTALLATIONS

CHAPTER R4—7 INTERFERENCE FROM PRECIPITATION-STATIC

Revised, 10th April, 1974

I GENERAL Interference to radio equipment as a result of precipitation-static and corona discharge shall be reduced to an acceptable level.

NOTE: Aircraft in which equipment utilising frequencies of less than 60 MHz is fitted are likely to need particular attention.

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SECTION R

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G—Approval Category G.
LA1, LA2, LA3—Approval Category LA Class 1, 2, 3.
U—Approval Category Unrestricted.

G—Approval Category G.
LA1, LA2, LA3—Approval Category LA Class 1, 2, 3.
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