



# Singapore Airworthiness Requirements

Publication of the  
Civil Aviation Authority of Singapore  
Singapore Changi Airport  
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## **CHAPTER 1.1**

# INTRODUCTION

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- 1 This Singapore Airworthiness Requirements is issued pursuant to paragraph 17A of the Singapore Air Navigation Order. This Singapore Airworthiness Requirements (SAR) sets out the minimum requirements, in respect of airworthiness of aircraft, aircraft engineering and maintenance requirements, licensing of aircraft maintenance engineers and the approval of persons and organisations, and must be complied with in addition to obligations imposed under the Air Navigation Order.
  
- 2 The requirements are effective from the date printed thereon and supersede any applicable requirements in force prior to that date. Certificates, approvals, licences or authorisations issued or granted previously by the DGCA will continue to be in force. Where the applicable requirements have been changed, and unless otherwise approved, compliance with the current Singapore Airworthiness Requirements will be necessary to retain the existing approval or to qualify for renewal of any certificate or document.
  
- 3 Failure to comply with any of these requirements may result in the suspension or revocation of the licence or approval and may be subject to the penalties provided under the Thirteenth Schedule of the ANO.

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## CHAPTER 1.2

# DEFINITIONS

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- 1 For the purposes of the Singapore Airworthiness Requirements the following terms and their definitions apply in addition to the definitions prescribed in the Singapore Air Navigation Order:
- 1.1 “**Aircraft Component**” means any assembly, instrument, mechanism, equipment, part, item, or accessory, including an airframe, aircraft engine, or propeller, that is used, or is intended to be used, in operating or controlling an aircraft in flight, or is installed in or attached to an aircraft.
- 1.2 “**Aircraft Equipment**” means any equipment provided in accordance with the Schedules to the Singapore Air Navigation Order and limited to equipment required to be approved.
- 1.3 “**Aircraft Material**” means material for use in components or equipment which could affect their airworthiness standard.
- 1.4 – Reserved –
- 1.5 “**Approved**” means approved by the Director-General of Civil Aviation (DGCA).
- 1.6 – Reserved –
- 1.7 “**Continuing airworthiness**” means the set of processes by which all aircraft comply with the applicable airworthiness requirements and remain in a condition for safe operation throughout their operating life
- 1.7A “**Director-General of Civil Aviation (DGCA)**” refers to the ‘Chief Executive’ as defined in the Air Navigation Order. This will include any person authorised by him to act on his behalf and any person acting in that capacity.
- 1.8 “**Time in service**” means the total time in service required to be recorded in the technical log by paragraph 9(7)(a) of the Air Navigation Order.
- 1.9 “**Maintenance programme**” means the maintenance schedule and related procedures, such as a reliability programme necessary for the safe operation of those aircraft to which it applies.

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## CHAPTER 1.3

# REGISTRATION OF AIRCRAFT

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### 1 Introduction

- 1.1 Pursuant to paragraph 4 of the Singapore Air Navigation Order, this Chapter prescribes the requirements for registration of aircraft in Singapore.
- 1.2 Registration of an aircraft is a one-off exercise unless there is a change of ownership.
- 1.3 Registration of an aircraft does not permit an aircraft to fly without a valid Certificate of Airworthiness.
- 1.4 For the purpose of this Chapter, where the significance of the owner of an aircraft is required for the application for a Certificate of Registration or for a change of ownership or for the notification for cancellation of a certificate of registration, and if the owner is a body corporate, the significance shall be that of the Managing Director, Secretary or other official duly authorised to sign under the seal of the company.

### 2 Application for a Certificate of Registration

- 2.1 Application shall be made on Form CAAS(AW) 39 and submitted to:

Civil Aviation Authority of Singapore  
Airworthiness/Flight Operations Division  
Singapore Changi Airport  
P O Box 1  
Singapore 918141

Note: The fees payable for this purpose are prescribed in the Twelfth Schedule of Singapore Air Navigation Order.

- 2.2 An applicant must satisfy the eligibility criteria of the Singapore Air Navigation Order.

### 3 Registration of Aircraft

- 3.1 Before an aircraft can be registered, proof of cancellation of foreign registration or, for a new aircraft, proof that the aircraft has never been registered elsewhere must be submitted to the DGCA.

Note: The applicant needs to apply separately to the Info-communications Media Development Authority (IMDA) for a Radio Station Licence.

**4 Change of Ownership**

- 4.1 A new Certificate of Registration is required when there is a change in the ownership of an aircraft. An application for registration of aircraft using Form CAAS(AW)39 in respect of the new owner shall be made to the DGCA. The aircraft shall not be flown again until such time as a new Certificate of Registration in respect of the new owner has been issued.
- 4.2 The original Certificate of Registration shall be returned to the DGCA. The former aircraft owner must complete either Section I or II on the reverse of the original Certificate of Registration prior to returning it to the DGCA.

**5 Notification for Cancellation of a Certificate of Registration**

- 5.1 Notification for cancellation of a Certificate of Registration shall be made by the owner of the aircraft.
- 5.2 The owner must complete either Section III or IV on the reverse of the original Certificate of Registration prior to returning it to the DGCA.
- 5.3 Notification of cancellation of an aircraft registration by the DGCA to a foreign authority will only be made if requested by the owner.

## CHAPTER 1.4

# ISSUE OF NOISE CERTIFICATE

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### 1 Introduction

- 1.1 Pursuant to paragraph 51(5) of the Air Navigation Order (ANO), this Chapter prescribes the requirements for the application for a Noise Certificate to be carried onboard a Singapore registered aircraft.
- 1.2 ICAO Annex 16, Volume 1, states that noise certification shall be granted or validated by the State of Registry on the basis of satisfactory evidence that the aircraft complies with the requirements that are at least equal to the applicable Standards specified in Annex. When the State of Registry is satisfied with the evidence provided, a document such as a noise certificate attesting to noise certification shall be approved by the State of Registry and shall be carried on board the aircraft. The noise certification standards adopted are those in ICAO Annex 16, Volume 1.
- 1.3 Application for a noise certificate is a one-time exercise done during the registration of the aircraft. A new application is required when the noise characteristics of the aircraft has changed such that either the noise level or the noise standard of the aircraft has changed.
- 1.4 In this Chapter, **Annex** means Volume I of Annex 16 to the Convention on International Civil Aviation entitled “Environmental Protection” and any amendment thereto.

### 2. Application for a Noise Certificate

- 2.1 Application shall be made on Form CAAS(AW)143 and submitted to:

Civil Aviation Authority of Singapore  
Airworthiness/Flight Operations Division  
Singapore Changi Airport  
P O Box 1  
Singapore 918141

**3 Requirements**

3.1 - Reserved-

3.2 Application for a noise certificate shall be submitted via Form CAAS(AW)143 and information provided in the form must be supported by:

- (a) Any relevant documents to show that the aircraft complies with the requirements that are at least equal to the applicable standards specified in Part II of the Annex. The supporting documents must contain, at the minimum, the following information,
1. The noise level achieved during type certification;
  2. The noise certification standard to which the aircraft is certificated ;
  3. The noise certification procedures used; and
  4. Any additional modifications that enable the aircraft to meet the relevant noise certification requirements of the Annex

Such documents may include the following;

- (i) a noise certificate issued by the State of Design; or
  - (ii) a statement made in the Flight Manual or Type Certificate, that the aircraft type conforms with the applicable environment requirements in Annex Part II and the associated noise data in the Flight Manual or in the Type Certificate Data Sheet.
- (b) Any other evidence as required by the DGCA for the consideration of the application.

3.3 Whenever the noise certification standard of an aircraft model has attained a more stringent level, an operator may submit a new application for a noise recertification together with documents to support the more stringent noise certification. A noise certificate may be issued by the DGCA upon satisfaction that the aircraft meets the applicable requirements of the more stringent noise standard.

**4. Validity of Noise Certificate**

4.1 Subject to paragraph 4.2, when the ownership of an aircraft has changed but the aircraft remains on Singapore's aircraft register, the noise certificate shall remain valid.

4.2 Pursuant to paragraph 60 of the ANO, the issued noise certificate of an aircraft shall be suspended or revoked if the aircraft ceases to comply with the applicable noise certification standards. Upon suspension or revocation of the noise certificate, the original certificate shall be returned to the DGCA.

4.3 The noise certificate shall cease to be valid when an aircraft is de-registered from Singapore's aircraft register. Original certificate shall be returned to the DGCA.

**SECTION 2**  
*AIRCRAFT AIRWORTHINESS*

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## CHAPTER 2.2

# ISSUE OF CERTIFICATES OF AIRWORTHINESS

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### 1 Introduction

- 1.1 Pursuant to paragraph 7 of the Singapore Air Navigation Order, this Chapter prescribes the requirements for the issue of a Singapore Certificate of Airworthiness.
- 1.2 An aircraft to which a certificate of airworthiness is issued shall be operated in compliance with the terms of that certificate and within the approved operating limitations in its flight manual.
- 1.3 The categories in which Certificates of Airworthiness may be issued are specified in the Singapore Air Navigation Order.
- 1.4 This Chapter spells out the general requirements for the issue of the Singapore Certificate of Airworthiness.

### 2 Application for a Certificate of Airworthiness

- 2.1 Application shall be made on Form CAAS(AW)29 and submitted to:

Civil Aviation Authority of Singapore  
Airworthiness /Flight Operations Division  
Singapore Changi Airport  
P O Box 1  
Singapore 918141

Note: The fees payable for this purpose are prescribed in the Twelfth Schedule of the Singapore Air Navigation Order.

### 2 Requirements

- 3.1 Prior to issuing any Certificate of Airworthiness, the DGCA may conduct an investigation to determine if the aircraft meets the Singapore airworthiness requirements. The applicant will have to furnish to the DGCA the information, data, reports, etc., prescribed in Chapter 2.2 Appendix 1 and to meet any additional requirements decided by the DGCA during the investigation.
- 3.2 The aircraft must have a type certificate that has been accepted by the DGCA, in accordance to SAR-21 Subpart A. Any Special Conditions imposed by the Airworthiness Authority of an exporting state must be acceptable to the DGCA.

- 3.3 The aircraft may be required to be made available for survey by the DGCA at suitable times and for such periods considered necessary. The owner shall prepare the aircraft to permit access as necessary and shall perform any checks and tests that may be requested.
- 3.4 A foreign Certificate of Airworthiness may, on application, be validated to permit a Singapore registered aircraft to be flown to Singapore without the issue of a Singapore Certificate of Airworthiness.
- 3.5 Each application for issue in Singapore of a Certificate of Airworthiness or revalidation of a foreign Certification of Airworthiness shall be accompanied with documents from an appropriately approved organisation or, when otherwise approved, an appropriately licensed aircraft maintenance engineer, which
- (a) state the type, model and manufacturer's serial number of the aircraft;
  - (b) substantiate that the aircraft complies with the airworthiness requirements appropriate to the aircraft type and which are acceptable to the DGCA;
  - (c) substantiate that all Singapore airworthiness requirements and special conditions applicable to the aircraft have been complied with;
  - (d) certify in regard to a used aircraft, that the aircraft and its records have been inspected and as far as can be reasonably determined the aircraft is safe to fly subject to the requirements prescribed in the approved flight manual or the Certificate of Airworthiness.
- 3.6 Upon being registered in Singapore, all work on the aircraft shall be undertaken by appropriately approved person or organisation or, when otherwise approved, a licensed aircraft maintenance engineer. A Certificate of Release to Service shall be issued and attached to the log book or other approved records together with full particulars of the work done.
- Note: Requirements for the compilation of aircraft, engine and variable pitch propeller log book entries and engineering records are prescribed in Section 4 Chapter 4.6.
- 3.7 The flight test carried out under the exporting country's authority may be accepted for the issue of a Singapore Certificate of Airworthiness. When the flight test is required by the DGCA, the owner shall be responsible to ensure that :
- (a) the aircraft and its engine(s) have been certified as fit for flight by appropriately licensed aircraft maintenance engineers.
- Note: A Certificate of Fitness for flight shall be issued in duplicate. One copy must be retained by the person issuing the Certificate.
- (b) a flight test schedule is prepared and is acceptable to the DGCA.
  - (c) the handling characteristics are satisfactory and climb performance equals or exceeds the scheduled performance.
  - (d) the flight tests are conducted by a person or organisation acceptable to the DGCA.

Note: The test may be witnessed by the DGCA.

- (e) a report on the flight tests in an acceptable format shall be submitted to the DGCA.

3.8 For new aircraft the owner shall arrange for the aircraft to be inspected during the course of construction to determine that it conforms in all essential aspects with the approved design and that its construction and assembly are satisfactory. The owner shall nominate a person, acceptable to the DGCA to carry such inspections. When necessary the DGCA may also inspect the aircraft in addition to the abovementioned inspections.

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## CHAPTER 2.2 : ISSUE OF CERTIFICATE OF AIRWORTHINESS

### APPENDIX 1

# GENERAL REQUIREMENTS

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## 1 Introduction

- 1.1 The following identifies the general requirements which must be satisfied prior to the issue of a Singapore Certificate of Airworthiness.

## 2 New Aircraft

- 2.1 The general requirements are as follows:

- (a) Export Certificates of Airworthiness for the aircraft, engines and propellers (as applicable).

The Certificates shall be endorsed with:

- (i) the national requirements with which the aircraft complies giving the title, issue numbers and effective date.
- (ii) such deviations from the national requirements as may have been authorised in writing by the Airworthiness Authorities which issue the Certificates.
- (iii) such additional special conditions that were required before the issue of the Certificates.
- (b) A list of applicable Airworthiness Directives together with:
- (i) A declaration of the Airworthiness Directives that had been complied with. Where alternate means of compliance are offered, the means chosen shall be stated.
- (ii) Identification of Airworthiness Directives that require repetitive compliance. Information as to when the next compliance is due must also be provided.
- (c) A list of Service Bulletins, including Alert Service Bulletins, complied with on aircraft engines, propellers (as applicable) and equipment.
- (d) Statement of Modification Status which shall include:
- (i) Customer options incorporated.

- (ii) Equipment incorporated.
- (e) Statement of compliance with mandatory equipment and radio apparatus requirements specified in the Schedules of the Singapore Air Navigation Order.
- (f) Statement of compliance with requirements specified in the Singapore Airworthiness Notices.
- (g) A list of defects, if any, that is to be rectified by the applicant at the time of issue of the Export Certificate of Airworthiness.
- (h) Equipment list.
- (i) Weighing report.
- (j) Weight and centre-of-gravity schedule.
- (k) Time/life limitations.
- (l) Records of compass system and magnetic compass swing.
- (m) Noise Certificate.

### **3 First-of-type Aircraft**

3.1 In addition to the requirements in paragraph 2, the following is required for a first-of-type aircraft exported to Singapore, unless otherwise notified:

- (a) Statement of build standard which shall include the aircraft specification.
- (b) A copy of the aircraft and engine type certificates and applicable supplemental type certificates.
- (c) Type certificate data sheets or specifications for aircraft, engine and propeller, including any supplemental type specifications.
- (d) Wiring diagrams.
- (e) Electrical load analysis.
- (f) Maintenance Review Board Report where applicable.
- (g) Maintenance Planning Data (which should include corrosion prevention and control programme, and structural integrity programme, where applicable)
- (h) Master Minimum Equipment List, where applicable.
- (i) Noise certificate.
- (j) One copy each of the following manuals:

- (1) Flight Manual or Pilot Operating Handbook (in addition to the copy for each aircraft).
  - (2) Operations Manual (in addition to the copy for each aircraft).
  - (3) Aircraft Maintenance Manual.
  - (4) Engine Maintenance Manual.
  - (5) Propeller Maintenance Manual.
  - (6) APU Maintenance Manual.
  - (7) Parts Catalogue.
  - (8) Standard Practices Manual.
  - (9) Structural Repair Manual.
  - (10) Structurally Significant Items.
  - (11) Loading Procedures Manual.
  - (12) Weight and Balance Manual.
  - (13) Non-destructive Testing Manual.
- (k) Complete sets of Service Bulletins for aircraft, engine, propeller and APU. Amendment service for the above documents must be provided to the DGCA.

### **3 Used Aircraft**

- 4.1 In addition to the requirements in paragraph 2 and, where applicable, in paragraph 3, the following is also required for a used aircraft:
- (a) A complete history of past operational uses of the aircraft.
  - (b) A complete history of the aircraft, engines, propellers, components and equipment including:
    - (i) The number of landings and pressurisation cycles.
    - (ii) The maintenance schedule to which the aircraft has previously been maintained, including previous check cycle and future check cycle.

Note : The owner shall be required to show proof that the maintenance schedule is adequate based on the reliability programme of the previous operator or its equivalent.

- (c) The time in service since new of any components of the aircraft, engines, propellers or equipment which are subject to mandatory life limitations.
- (d) The time in service since new and since overhaul of any components of the aircraft, engines, propellers or equipment which are subject to an approved overhaul period.
- (e) Details of all changes of major structural components such as wings, tailplanes, helicopter rotors or transmission components and histories of the replacing components.
- (f) Details of major structural repairs including the nature of damage in each case.
- (g) The particulars and results of airworthiness acceptance tests.

## CHAPTER 2.3

# RENEWAL OF CERTIFICATE OF AIRWORTHINESS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 Introduction

- 1.1 Pursuant to paragraph 7(8) of the Singapore Air Navigation Order, this Chapter prescribes the requirements for renewal of a Certificate of Airworthiness.

Note: Singapore Certificates of Airworthiness are normally issued or renewed for periods not exceeding one year.

### 2 Application for Renewal of Certificate of Airworthiness

- 2.1 Application shall be made on Form CAAS(AW)29 and submitted to:

Civil Aviation Authority of Singapore  
Airworthiness/Flight Operations Division  
Singapore Changi Airport  
P O Box 1  
Singapore 918141

- Note:
- (1) The fees for renewal of a Certificate of Airworthiness are prescribed in the Schedules of the Singapore Air Navigation Order.
  - (2) The application and all documents required by this Chapter should be submitted at least two weeks prior to the expiry date of the Certificate.

### 3 Requirements

- 3.1 The renewal of a Certificate of Airworthiness is dependent on evidence being provided that the aircraft complies with the appropriate airworthiness requirements and is airworthy.
- 3.2 An inspection of the aircraft may be required but all relevant records shall be reviewed prior to the renewal of the Certificate of Airworthiness. The depth and extent of the inspection, if required, will depend on:
- (a) the age of the aircraft, areas and types of operation and conditions of storage.
  - (b) the extent of any unscheduled work that has been carried out on the aircraft since the last renewal following such events as serious or persistent defects, defects or damages requiring major repairs or modifications, inspections completed following hard or overweight landings or abnormal stresses during flight or on the ground, corrosion in major structure, etc.

- (c) evidence that the approved maintenance schedules or approved overhaul and/or replacement periods for the aircraft and its components have been fully observed.
- (d) evidence that airworthiness requirements or instructions, such as mandatory modifications and inspections, airworthiness directives, etc., prescribed or approved by the DGCA, for the aircraft and its components, have been complied with fully.
- (e) evidence of, observance of the aircraft or component manufacturers' recommendations, such as service bulletins, service letters, etc., which may affect the airworthiness of the aircraft.

3.3 Prior to renewal of the Certificate of Airworthiness the aircraft may be required to be made available for survey by the DGCA. If a survey is required, the owner shall have the aircraft prepared for inspection in an acceptable condition to enable tests and inspections to be made. Additional work may be required by the DGCA following a survey of the aircraft.

3.4 Unless there is a system of monitoring the weight and centre of gravity of the aircraft, the aircraft should be weighed prior to the initial issue of a Singapore Certificate of Airworthiness. For all aircraft, it should be re-weighed within two years after the date of manufacture and thereafter at intervals not exceeding five years. The weighing and centre of gravity report shall be submitted in a prescribed format to the DGCA.

3.5 If a flight test is required by the DGCA, the results of the test and related test information and data shall be submitted in an acceptable format, to the DGCA. In lieu of an annual flight test, a programme for aircraft performance and engine condition monitoring must be implemented.

#### **4 Records and Log Books**

4.1 The relevant log books, modification record book and maintenance records forming part of log books, and records permitted to be kept by other approved means shall be submitted to the DGCA prior to renewal of the Certificate of Airworthiness.

4.2 Full particulars of the work done relating to the renewal of the Certificate of Airworthiness shall be entered and certified in the log books or other approved records.

4.3 Copies of the valid Certificates of Releases to Service/Schedule Maintenance Inspection and Certificate of Maintenance Review should be submitted to the DGCA prior to the renewal of the Certificate of Airworthiness.

#### **5 Aircraft Documents**

5.1 Unless otherwise required, the aircraft flight manual and maintenance schedule shall be made available for survey if required by the DGCA. The owner shall ensure that these documents together with the maintenance, overhaul, repair manuals and crew manuals, etc., are up-to-date.

## CHAPTER 2.4

# EXPORT CERTIFICATE OF AIRWORTHINESS

EFFECTIVE DATE : 3 MAY 2016

REVISION NO : 22 (ISSUE 2)

### 1 Introduction

- 1.1 This Chapter prescribes the requirements to an Export Certificate of Airworthiness under paragraph 7A of the Air Navigation Order.
- 1.2 The Airworthiness Authority of the country of import usually requires evidence from the Airworthiness Authority of the country of export as to the airworthiness of the aircraft concerned. The evident of airworthiness adopted and accepted internationally is usually in the form of an Export Certificate of Airworthiness.
- 1.3 The Export Certificate of Airworthiness does not, by itself, give authority for the aircraft to be flown. Such authority will have to be obtained from the Airworthiness Authority of the country in which the aircraft is to be registered.

### 2 Application

- 2.1 An application for an Export Certificate of Airworthiness shall be made on Form CAAS(AW)36. The application shall be
  - (a) accompanied by relevant documents and other evidence specified in Chapter 2.2 and Chapter 2.3 of this Section;
  - (b) accompanied by documents specifying the requirements or design standards with which the aircraft does not comply and a letter from CAAS to notify that an exemption from the Air Navigation Order or the Technical Requirements had been granted in respect of the non-compliance;
  - (c) accompanied by evidence that the importing state requires an Export Certificate of Airworthiness; and
  - (d) submitted to:

Civil Aviation Authority of Singapore  
Airworthiness/Flight Operations Division  
Singapore Changi Airport Terminal 2  
P O Box 1  
Singapore 918141
- 2.2 The application and all required documents should be submitted at least one month prior to the date of the intended export of the aircraft.

**3 Requirements**

- 3.1 The aircraft concerned shall have a valid Certificate of Airworthiness to be eligible for the grant of an Export Certificate of Airworthiness.
- 3.2 For the purposes of the grant of an Export Certificate of Airworthiness, CAAS may consider an aircraft as “new” if it meets all of the following criteria:
- (a) The aircraft has only flown for any or all of the following purposes:
    - (i) testing the aircraft;
    - (ii) demonstrating the aircraft with a view to the sale of that aircraft;
    - (iii) proceeding to or from a place at which the aircraft is to be demonstrated; or
    - (iv) delivering the aircraft to a person who has agreed to buy or lease the aircraft.
  - (b) The aircraft has, from its date of manufacture to the date of application for an Export Certificate of Airworthiness, been under the sole ownership of the manufacturer or dealer authorised by the manufacturer; and
  - (c) The aircraft has not accumulated flight cycles or flying hours that requires its first maintenance inspection as defined in its approved Maintenance Schedule. Inspection and servicing tasks that are necessary for flight operations as identified in the approved Maintenance Schedule are not considered as ‘maintenance inspection’ for this purpose.
- 3.3 For the purpose of the grant of an Export Certificate of Airworthiness, CAAS may consider an aircraft that does not meet the criteria set out in paragraph 3.2 as “used”.
- 3.4 CAAS may record additional information in the Export Certificate of Airworthiness granted to a new aircraft. Such additional information may include cycles, hours and purposes of the flights conducted while the aircraft was registered in Singapore.
- 3.5 The aircraft concerned shall be de-registered from Singapore’s register prior to the issue of an Export Certificate of Airworthiness.

- Note:
- (1) CAAS does not require that an aircraft being exported from Singapore be issued with an Export Certificate of Airworthiness.
  - (2) An Export Certificate of Airworthiness is not a Certificate of Airworthiness for the purposes of the Singapore Air Navigation Order.
  - (3) The Singapore Export Certificate of Airworthiness will certify only to the eligibility of the aircraft to receive the Singapore Certificate of Airworthiness in a particular category and unless specifically endorsed will not certify compliance with the airworthiness requirements of the importing country.
  - (4) - Reserved-

**CHAPTER 2.5****PERMIT TO FLY**

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

**1 Introduction**

- 1.1 Pursuant to paragraph 6(1) of the Air Navigation Order (ANO), an aircraft shall not be flown unless there is a valid Certificate of Airworthiness, issued or rendered valid under the law of the country in which the aircraft was registered or under the law of the State of the operator, and any conditions subject to which the certificate was issued or rendered valid are complied with. It should be noted that paragraph 7(9) of the ANO stipulates that a Certificate of Airworthiness issued in respect of an aircraft shall cease to be in force if the aircraft or such of its equipment as is necessary for the airworthiness of the aircraft is not overhauled, repaired or modified in a manner and with material of a type approved by the DGCA. Any failure to maintain an aircraft in an airworthy condition as defined by appropriate airworthiness requirements shall render the aircraft unairworthy for flight until the aircraft is restored to an airworthy condition.
- 1.2 Pursuant to ANO paragraph 6(1)(i)(b), the Chief Executive of CAAS may issue a permit to fly, subject to applicable conditions and limitations, to allow the aircraft to fly without fare-paying passengers to a facility at which the aircraft can be repaired and/or otherwise restored to an airworthy condition. The circumstances under which a permit may be issued are set out in paragraph 1.3 below.
- 1.3 A Permit to Fly may be issued under the following circumstances:
- (a) structural damage – damage occurring to a primary or principle structures and/or any structures that affects the normal operation of the aircraft;
  - (b) system failures – failures in aircraft systems that affects the normal operation of aircraft;
  - (c) at any other times determined by the DGCA.
- provided that the aircraft is capable of safe flight.
- 1.4 The requirements stipulated in this chapter apply to all Singapore registered aircraft when the Certificate of Airworthiness has ceased to be in force.
- 1.5 An operator may request for a permit to fly from the DGCA to allow the aircraft to fly when the Certificate of Airworthiness has ceased to be in force for the purpose of positioning the aircraft to a place where repairs for returning to service are to be performed.

1.6 The permit to fly does not constitute an authorisation to operate in the airspace of other States. The operator shall seek the permission and/or clearances from the appropriate authorities of the respective States over which the flight will take place prior undertaking such flights.

## **2 Application for Permit to Fly**

2.1 An application for a permit to fly must be submitted in writing and shall include at least the following:

- (a) the name and address of registered owner and its operator;
- (b) the make, model, serial number and registration marks of the aircraft;
- (c) the purpose of the flight;
- (d) the proposed itinerary;
- (e) the crew required for the flight;
- (f) details of the aircraft damage and/or defects
- (g) details of non-compliance with applicable airworthiness requirements;
- (h) the reasons for the inability to effect a proper permanent rectification;
- (i) details of and justification for any purposed temporary repair;
- (j) in the case of structural damage requiring temporary repair (before the flight is undertaken), details of the appropriate approved manufacturer's recommendation, operator's recommendation and confirmation that the temporary repair has been made;
- (k) any restriction the applicant considers necessary for safe operation of the aircraft;
- (l) any other information as required by the DGCA for the purpose of prescribing operating limitations.

2.2 In evaluating the application for a permit to fly, the DGCA may inspect the aircraft to make a determination as to the conditions and limitations to be imposed for the issuance of permit to fly.

2.3 Issuance of a permit to fly is subjected to the DGCA's satisfaction that the aircraft is in an acceptable condition to make the flight and/or that the aircraft is capable of safe flight.

2.4 The aircraft operator shall fulfil the conditions and limitations specified in the permit to fly before the aircraft is permitted to fly.

2.5 A copy of the permit to fly shall be carried on board the aircraft at all times when flown under the terms of the permit and be produced upon request.

**3 Ferry Flight Authorisation**

- 3.1 Pursuant to paragraph 6(1)(i)(aa) of the ANO, a Singapore AOC holder may be granted authorisation to fly its aircraft that may not meet applicable airworthiness requirements but is capable of safe flight, to a base where the necessary maintenance or repairs can be performed. This authorisation requires the AOC holder to:
- (a) assess if its aircraft is capable of safe flight even though it does not meet applicable airworthiness requirements; and
  - (b) set conditions and limits in relation to the flight operating under this authorisation so as to fly to base where the required repair and/or maintenance is to be performed.
- 3.2 Such authorisations granted shall be known as a “Ferry Flight Authorisation” and be subjected to the conditions as set out in the attachments to the AOC holder’s operations specifications.
- 3.3 A Ferry Flight Authorisation is issued to an AOC holder:
- (a) only when the DGCA is satisfied that the AOC holder is capable of evaluating the condition of the aircraft and of setting the appropriate operating limitations for each flight operating under such authorisation; and
  - (b) at the sole discretion of the DGCA.
- 3.4 The holder of a Ferry Flight Authorisation shall inform the DGCA in writing within 2 days of any flights conducted under the authorisation.

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**SECTION 3**  
*COMPONENT AND EQUIPMENT*  
*AIRWORTHINESS*

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## CHAPTER 3.7

# REQUIREMENT FOR COMPASS SWING

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

1.1 Pursuant to paragraph 12(4) of the Air Navigation Order, this Chapter prescribes the requirements for Singapore aircraft in respect of direct reading compasses, gyro-stabilised remote indicating compass systems and non gyro-stabilised remote indicating compass systems.

1.3 For the purpose of this Chapter, the following definitions shall apply.

**Calibration** means the measurement of residual deviations of a compass installed in an aircraft;

**Deviation** means the angle required to be added algebraically to the compass reading to obtain the aircraft magnetic heading; and

**Standby Compass** means a direct reading compass which is not used as the primary heading reference.

### 2 COMPASS SWING

2.1 The operator of a Singapore aircraft shall conduct a compass swing to calibrate each installed compass in accordance with the conditions and time intervals prescribed in the maintenance schedule. In the event the maintenance schedule does not prescribe a time interval, a compass swing shall be conducted at least once every twelve months.

2.2 The operator shall verify the accuracy of the compass when the accuracy of the compass is in doubt and shall carry out a compass swing when necessary.

2.3 A compass swing shall be performed in accordance with approved data and documents, unless otherwise permitted by the DGCA. The presence of magnetic interference shall also be taken into consideration during the compass swing.

2.4 Deviation of the compass at any heading shall be within a limit stipulated by the aircraft manufacturer. In the absence of such limits specified by the aircraft manufacturer, the deviation shall be within a limit acceptable to the DGCA.

**3 Recording**

- 3.1 A record of the compass swing shall be made in the aircraft log book or in any other manner acceptable to the DGCA.
- 3.2 A compass deviation card shall be made available for the primary standby compass, and shall contain at least the following information:
- (a) the magnetic heading and the compass reading necessary to achieve the magnetic heading at the cardinal and intermediate 30 degree headings;
  - (b) the date of the compass swing;
  - (c) the type and serial number of the compass; and
  - (d) the identity and signature of the person responsible for the compass swing.
- 3.3 The compass deviation card shall be protected against water or other damage and be positioned so that it can be easily read during flight.

## CHAPTER 3.10

# FIRE EXTINGUISHING AGENTS

EFFECTIVE DATE : 15 DECEMBER 2016

REVISION NO : 24 (ISSUE 2)

### 1 General

- 1.1 Pursuant to paragraph 12(2) of the Air Navigation Order (ANO), the equipment to be provided in a Singapore aircraft shall be that as specified in the Fifth Schedule. Scale A of the Fifth Schedule of the ANO requires all aircraft on all flights to carry one portable non-toxic type fire extinguisher for each enclosed passenger and crew compartment. This chapter specifies the requirements for fire extinguishing agents for use on Singapore aircraft.
- 1.2 The operator of a Singapore aircraft shall ensure the type of fire extinguishing agent used on the aircraft meets the requirements in this Chapter.

### 2. Portable fire extinguisher

- 2.1 The extinguishing agent used in any portable fire extinguishers in an aircraft for which the individual Certificate of Airworthiness is first issued (whether in Singapore or elsewhere) on or after 31 December 2018 shall not be of a type listed in Annex A, Group II of the *Montreal Protocol on Substances That Deplete the Ozone Layer*, 8th Edition, 2009.

### 3. Built-in fire extinguisher for lavatory disposal receptacle

- 3.1 The extinguishing agent used in a built-in fire extinguisher for each lavatory disposal receptacle for towels, paper or waste in an aircraft for which the individual Certificate of Airworthiness is first issued (whether in Singapore or elsewhere) on or after 31 December 2011 shall not be of a type listed in Annex A, Group II of the *Montreal Protocol on Substances That Deplete the Ozone Layer*, 8th Edition, 2009.

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**SECTION 4**  
*ENGINEERING AND MAINTENANCE*  
*ADMINISTRATION*

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## CHAPTER 4.1

# GENERAL REQUIREMENTS FOR MAINTENANCE OF AIRCRAFT AND AIRCRAFT COMPONENTS

EFFECTIVE DATE : 11 JANUARY 2017

REVISION NO : 25 (ISSUE 2)

### 1 General

- 1.1 Pursuant to paragraphs 9 and 10 of the Air Navigation Order, this Chapter prescribes the requirements for Singapore aircraft in respect of:-

**Maintenance of aircraft.** This work must be conducted in accordance with a maintenance schedule prepared by the owner or operator of an aircraft and approved by the DGCA.

Note: The contents of a maintenance schedule are dependent on the category of an aircraft, its complexity and the system of control over maintenance by the owner or operator. Specific requirements are stated in Chapter 4.3.

**Overhaul, repair, inspection and modification of aircraft, components or equipment and replacements of components and equipment.** This work must be undertaken in accordance with approved conditions and procedures, approved components, parts or material must be used and a certificate of release to service must be issued on completion of the work.

### 2 Responsibilities for Airworthiness

#### 2.1 Owner's or Operator's Responsibilities

The owner or operator of an aircraft is responsible that maintenance work on his aircraft are conducted in accordance with the Singapore airworthiness requirements and the aircraft is maintained in an airworthy condition. He shall ensure that:

- (a) All maintenance, mandatory modifications and inspections, overhauls or replacements on the aircraft, its engines, components or equipment are completed within any required periods and in accordance with the approved maintenance schedules, or other approved worksheets as applicable.
- (b) Unless otherwise agreed by the Chief Executive, all work is undertaken by a SAR-145 approved maintenance organisation.
- (c) The SAR-145 approved maintenance organisation is notified of the work to be undertaken at each scheduled check or inspection, including rectification of defects or damage and any mandatory work to be completed unless the maintenance schedules adequately specify such work as may be applicable.

- (d) The aircraft is not flown unless all work has been completed and certified on documents appropriate for the work and the pilot is notified of the status of the aircraft.
- (e) When an aircraft has had abnormal loads applied in flight, experienced hard or overweight landings, or been struck by lightning, it shall be inspected in accordance with the manufacturers requirements or other schedules approved by the DGCA and the results of the inspection plus details of repairs made are entered in the aircraft log book or other approved records and when appropriate the aircraft technical log.
- (f) Maintenance schedules and worksheets pertinent to his aircraft, components or equipment are revised whenever modifications to the aircraft or changes in maintenance practices or category of operation cause them to be inapplicable. Such revisions must be approved by the DGCA and distributed to all persons or organisations responsible for maintenance of his aircraft.
- (g) Particulars of all work completed on his aircraft are, as appropriate, entered in the technical log, or other appropriate log book or approved records system together with the applicable certification document.
- (h) Approved data and documents are revised as soon as possible after receipt of amendment advice from the manufacturer and appropriate staff are advised of amendments that affect airworthiness.

Note: The data and documents which may be approved for use in aircraft maintenance are specified in paragraph 3.2.

- (i) Where the flight or operating characteristics of the aircraft or its components may have been affected by maintenance or other work, the aircraft shall not be released to service until it has been certified as fit for flight and tested in flight in accordance with an approved test schedule, unless other procedures have been approved.

Note: Requirements for design of a certificate of fitness for flight under 'A' Conditions and specified in Appendix 1.

- (j) The effect of the work on the empty weight and centre of gravity position of the aircraft shall be calculated. Where significant changes have occurred the results shall be submitted to DGCA who will determine whether re-weighing and/or preparation of a new weight schedule is required.
- (k) The DGCA and authorised officers are permitted access to his aircraft and establishment to assess whether these requirements are being observed; and, to inspect documents, aircraft, components, equipment, or work in progress to assess the competence and diligence of staff engaged in aircraft maintenance and other work.

2.2 Maintenance Organisation's Responsibilities

A person or organisation responsible for maintenance or other work on aircraft shall carry out the work under and in accordance with the requirements stipulated in the SAR-145.

**3 General Requirements for the Conduct of Maintenance and Other Work**

3.1 Aircraft Components, Equipment and Materials

Such items shall not be used unless they comply with any mandatory airworthiness requirements and an Authorised Release Certificate or other acceptable document has been provided. Replacement items must be either identical with those installed in the aircraft, component, equipment or approved alternatives.

3.2 Approved Data and Documents

3.2.1 The following data or documents are approved, except when the DGCA has directed or notified otherwise:

- (a) Those aircraft, component or equipment manufacturer's maintenance data as specified in SAR-145.
- (b) Data or design documents issued by the approved signatories and within the scope of a design organisation approved by the DGCA.
- (c) Requirements specified by the United States Federal Aviation Administration Advisory Circular 43.13-1 as revised, provided any limitations by an aircraft manufacturer in the documents specified in paragraph 3.2.1(a) in respect of structural repairs or other work are observed.

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**CHAPTER 4.1 : GENERAL REQUIREMENTS FOR AIRCRAFT  
MAINTENANCE**

**APPENDIX 1**

**CERTIFICATE OF FITNESS FOR FLIGHT**

EFFECTIVE DATE : 15 AUGUST 2006

REVISION NO : 12 (ISSUE 2)

The Certificate shall be as follows:

**CERTIFICATE OF FITNESS FOR FLIGHT**

**AIRCRAFT REGISTRATION**

It is hereby certified that the aircraft defined hereon has been inspected and is fit for flight provided it is properly loaded.

This Certificate is valid until \_\_\_\_\_ or until the airworthiness condition of the aircraft is altered, whichever is earlier.

Signed \_\_\_\_\_ Authorisation No \_\_\_\_\_  
Airframe

Date \_\_\_\_\_

Signed \_\_\_\_\_ Authorisation No \_\_\_\_\_  
Engines

Date \_\_\_\_\_

- Note:
- (1) The maintenance organisation shall ensure that a Certificate of Fitness for Flight is issued after the aircraft's airframe and engine integrity are verified by the appropriately authorised certifying staff.
  - (2) A Certificate of Fitness for Flight shall be certified only by holder(s) of an appropriate aircraft maintenance licence with privileges in airframe, engine or both.
  - (3) The period of validity shall be stated but shall not exceed 7 days.
  - (4) The Certificate shall be issued in duplicate and one copy kept elsewhere than in the aircraft.
  - (5) If the original airworthiness condition of the aircraft is affected during the period of validity, the Certificate shall be re-issued.

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## CHAPTER 4.1.1

# SCOPE OF RESPONSIBILITIES OF AIRCRAFT MAINTENANCE LICENCE HOLDERS AND APPROVED OR AUTHORISED PERSONS OR ORGANISATIONS

EFFECTIVE DATE : 15 AUGUST 2006

REVISION NO : 12 (ISSUE 2)

### 1 General

1.1 This Chapter prescribes the scope of responsibilities of licensed aircraft maintenance personnel pursuant to paragraphs 10 and 11 of the Air Navigation Order for the issue of certificates of Release to Service for the completion of overhauls, maintenance, modification, replacements, repairs and inspections.

Note: Persons authorised or approved to perform the functions of a licensed aircraft maintenance personnel shall also comply with the provisions of this Chapter.

1.2 A person who is appropriately licensed, authorised or approved shall not certify for the completion of work unless he has familiarised himself with all current information necessary for the work.

Note: When the work involves the assembly or any disturbance of a vital point or control system to which the SAR applies, any duplicate inspection required must be certified before the relevant Certificate of Release to Service is issued.

1.3 For the purpose of this Chapter, the following definitions shall apply:

Overhaul - is a major work operation which involves dismantling, inspection and replacement of any necessary parts, reassembly and complete functional testing to specifications and renewal of operational life.

Modification - is any change made to an aircraft, engine, propeller, component, or equipment and their installation.

Replacement - is the removal of a part or component and its replacement with an identical part or component or substitution of another approved part.

Repair - is any rectification work which is not covered by any of the above definitions.

- Inspection - is any work necessary to determine the condition of a component, whether damage or defects exist, or work has been completed in an approved manner.
- Maintenance - is any scheduled maintenance inspection (SMI) or other work required by the approved maintenance schedule.
- Condition - is the physical state of a part or component.
- Assembly - means that items are put together, fitted, attached, installed, connected, secured, or adjusted correctly in the approved manner.
- Functioning - means ensuring that components or systems operate correctly and in the approved manner.
- Electronic Component - means a component which contains semi-conductor parts or microprocessors.
- Primary structure - means those parts of the structure which contribute significantly to carrying flight, ground or pressurisation loads, the failure of which could endanger the safety of the aircraft.

## **2 Privileges of an Aircraft Maintenance Licence**

- 2.1 The aircraft maintenance licence alone does not permit the holder to issue certificates of release to service (CRS). To issue a CRS, the licenced holder must in addition hold a certification authorisation issued by a CAAS approved organisation.
- 2.2 Subject to the rating and any limitations stated on an aircraft maintenance licence, the holder may be authorised to certify for the maintenance, modifications, replacements, repairs and inspections as appropriate.
- 2.3 There are many areas where work being carried out on an aircraft could affect other systems, equipment or components outside the licence holder's privileges. Where an overlap occurs the licence holder primarily responsible for the system must ensure such other work are certified by another licence holder with the appropriate privileges.

## **3 SAR Section 7 Aircraft Maintenance Engineer Licence Privileges**

### **3.1 Category Airframe (A)**

- 3.1.1 This category is responsible for the condition, assembly and functioning of all parts of the aircraft, components, equipment and systems not included in other categories.
- 3.1.2 Certificates of Release to Service may be issued for any maintenance, modification, replacement, repair or inspection of components provided that the work has not involved any of the following:

- (a) Bolted joints requiring special techniques.
- (b) Complete riveted joints in primary structures.
- (c) Complete glued joints in primary structures.
- (d) Bonded assemblies in primary structures.
- (e) Fibre reinforced plastic/epoxy primary structures.
- (f) Cotton, linen, polyester /fibre laminate fabric covering of a complete fuselage or aerofoil.
- (g) Welded and brazed joints.
- (h) Non-destructive tests except dye penetrant and boroscopic inspections.
- (i) The disturbing of individual parts of units which are supplied as bench tested units, except for the replacement or adjustment of items normally replaceable or adjustable in service where subsequent functioning may be proved without the use of test equipment additional to the test equipment used for normal functioning check.

3.1.3 Work requiring the issue of Certificates of Release to Service may also be undertaken on electrical, instrument and radio systems associated with airframe systems on which the appropriately licensed aircraft maintenance engineer is rated, provided it is not also associated with engines and auxilliary power units and is within the following limitations:

- (a) Electrical Systems
  - (i) Aircraft in Category A Groups 1, 5 and 6 (single-engine rotorcraft only): All work except complete overhaul, extensive modifications or new installations.
  - (ii) Aircraft in Category A Groups 2, 3, and 6 (twin or more engine rotorcraft): Replacement of components provided that functioning checks to prove serviceability do not require the use of test apparatus.
  - (iii) Aircraft in Category A Group 4 (below 5700 kg, MTWA): Replacement of non-electronic components provided that functioning checks to prove serviceability do not require the use of test apparatus.

(b) Instrument Systems

Note: Certificates of Release to Service for work involving compass compensation and adjustment may not be issued unless the licence is endorsed for this purpose.

- (i) Aircraft in Category A Groups 1, 5 and 6 (single-engine rotorcraft only): All work except complete overhaul, extensive modifications or new installations.
  - (ii) Aircraft in Category A Groups 2, 3 and 6 (twin or more engine rotorcraft): Replacement of components provided that functioning checks to prove serviceability do not require the use of test apparatus. Integrated flight systems and electronic automatic pilot systems are excluded.
  - (iii) Aircraft in Category A Group 4 (below 5700 kg, MTWA): Replacement of non-electronic components provided that functioning checks to prove serviceability do not require the use of test apparatus.
- (c) Radio Systems
- Replacement of components of VHF Communication Systems installed in aircraft below 2,730 kg MTWA.

3.2 Category Engine (C)

3.2.1 This category is responsible for the condition, assembly and functioning of the engine installation, rotorcraft transmission, auxiliary power unit and associated operational systems or devices required for their operation.

3.2.2 Certificates of Release to Service may be issued for any maintenance modification, replacement, repair or inspection of components or parts provided that the work has not involved any of the following:

- (a) Dismantling of a piston engine other than to obtain access to the pistons.
- (b) Dismantling of main casings or main rotating assemblies of a turbine engine except where the particular engine maintenance manual provides instructions for the dismantling and replacement of main casings or rotating assemblies and provided that suitable training on such procedure and the use of any required tool or equipment has been received.
- (c) Removing or dismantling of reduction gears.
- (d) Dismantling of rotorcraft transmission gearbox casings except performed for the purpose of internal inspection and in accordance with the appropriate maintenance manual.
- (e) Propeller balancing, except those propellers which require check balancing in accordance with the aircraft maintenance manual, and provided that suitable training on the balancing equipment and procedure has been received.
- (f) Welded and brazed joints.
- (g) Non-destructive tests except colour contrast dye penetrant and boroscopic inspections.

- (h) The disturbing of individual parts of units which are supplied as bench tested units, except for the replacement or adjustment of items normally replaceable or adjustable in service where subsequent functioning may be proved without the use of test equipment additional to the test equipment used for normal functioning checks.
- 3.2.3 Work requiring the issue of Certificates of Release to Service may also be undertaken on electrical and instrument systems associated with engine systems within the following limitations:
- (a) Electrical Systems
    - (i) Engine in Category C Groups 1, 2 and 3: All work except complete overhaul, extensive modifications or new installations.
    - (ii) Engine in Category C Groups 4, 5, 6 and 7 installed on aircraft below 5700 kg, MTWA: Replacement of non-electric components provided that functioning checks to prove serviceability do not require the use of test apparatus.
  - (b) Instrument Systems
    - (i) Engine in Category C Groups 1, 2 and 3: All work except complete overhaul, extensive modifications or new installations.
    - (ii) Engine in Category C Groups 4, 5, 6 and 7 installed on aircraft below 5700 kg, MTWA: Replacement of non-electric components provided that functioning checks to prove serviceability do not require the use of test apparatus.
- 3.3 Category Electrical (E)
- 3.3.1 This category is responsible for the condition, assembly and functioning of all parts and components of the electrical systems, including the associated data buses and multiplexed systems. Instrument and radio systems are excluded.
- 3.3.2 Certificates of Release to Service may be issued for any maintenance, modification, replacement, repair or inspection of components or parts provided the work has not involved the disturbing of individual parts of units which are supplied as bench tested units. The replacement or adjustment of items normally replaceable or adjustable in service and where subsequent functioning may be proved without the use of test equipment additional to the test equipment used for normal functioning checks is permitted.
- 3.3.3 Work requiring the issue of Certificates of Release to Service may also be undertaken on instrument systems of Category I Group 1 or 2 aircraft for which an electrical rating is held, within the following limitations:
- (a) Replacement of electrically operated components of instrument systems where correct functioning can be established without the use of specialised test equipment.
  - (b) Repairs and replacement of interwiring.

3.4 Category Instrument (I)

3.4.1 This category is responsible for the condition, assembly and functioning of all parts and components of all indicating, recording and navigational instrument systems, automatic flight control systems, integrated flight systems, compass systems, pressurisation systems and oxygen systems, including the associated data buses and multiplexed systems. Radio system instruments are excluded.

3.4.2 Certificates of Release to Service may be issued for any maintenance, modification, replacement, repair or inspection of components or parts provided the work has not involved the disturbing of individual parts of instruments of units which are supplied as bench tested units. The replacement or adjustment of items normally replaceable or adjustable in service and where subsequent functioning may be proved without the use of test equipment additional to the test equipment used for normal functioning checks is permitted.

3.4.3 Work requiring the issue of Certificates of Release to Service may also be undertaken on electrical systems of Category E Group 1 or 2 aircraft for which an instrument rating is held, within the following limitations:

(a) Replacement of components in electrical systems where correct functioning can be established without the use of specialised test equipment.

(b) Repair and minor replacement of interwiring.

3.5 Category Radio (R)

3.5.1 This category is responsible for the condition, assembly and functioning of all parts and components of the radio communication, radio navigation and radar systems, including radio components of composite instruments, associated data buses and multiplexed systems.

3.5.2 Certificates of Release to Service may be issued for any maintenance, modification, replacement, repair or inspection of components or parts provided the work has not involved the disturbing of individual parts of radio equipment or units which are supplied as bench tested units. The replacement or adjustment of items normally replaceable or adjustable in service and where subsequent functioning may be proved without the use of test equipment additional to the test equipment for normal functioning checks is permitted.

**4 SAR-66 Aircraft Maintenance Licence Privileges**

4.1 Details of the SAR-66 licence privileges are found in SAR-66.20.

**5 Responsibilities of Authorised or Approved Persons or Organisations**

5.1 The extent of any approval of a person to undertake and certify for maintenance, overhaul, modification, replacement, repair or inspection of components or parts will be in accordance with the terms of the approval.

## CHAPTER 4.3

# MAINTENANCE OF AIRCRAFT

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

1.1 This chapter prescribes the requirements for the preparation of:

- (a) maintenance of schedules; and
- (b) systems of control over maintenance on aircraft.

### 2 Maintenance Schedules

2.1 Owners or operators of Singapore aircraft shall prepare and submit maintenance schedules, detailing the maintenance required at specific intervals on the aircraft, to the DGCA for approval.

2.2 Singapore operators operating foreign-registered aircraft shall provide, for the use and guidance of maintenance and operational personnel concerned, a maintenance schedule approved by the State of Registry. A copy of such a maintenance schedule shall be submitted to the DGCA when the operator applies to include or use a foreign-registered aircraft in his operation.

2.3 All maintenance schedules shall contain the following information:

- (a) The owner's or operator's registered name and address.
- (b) The makes, type and series reference of the aircraft, its engine(s) and propeller(s).
- (c) The nationality and registration marks of the aircraft to which the schedule is applicable.
- (d) The periods at which the aircraft, its components, equipment and their installations shall be inspected, the extent of each inspection, and practices and procedures to be followed.

Note: Specific references in the maintenance schedules to the aircraft, component or equipment manufacturers current maintenance and overhaul manuals may be acceptable, instead of including the complete information, provided any aspects of the work on aircraft which are additional to or vary from the manufacturer's information are detailed in the maintenance schedule.

- (e) The periods at which components or equipment are inspected, checked, tested, calibrated etc and cleaned, lubricated, adjusted etc. as applicable and the practices and procedures to be followed.

- (f) A statement specifying the procedures for recording aircraft time in service, the periods at which scheduled inspections and other work are to be done, the periods at which a Certificate of Maintenance Review is to be issued and procedures for its issue.
- (g) A schedule detailing components or equipment which are to be overhauled or retired from service at specified calendar (elapsed) time, or flying time periods or other approved service life period.
- (h) Procedures and documentation for certification of all checks and inspections, issue of a Certificate of Maintenance Review and issue of a Certificate of Release to Service.

Note: The requirements for issue of Certificate of Maintenance Review are specified in Chapter 4.3 Appendix 1.

### **3 Systems of Control Over Maintenance on Aircraft**

3.1 An associated system of control over maintenance of aircraft is also required for aircraft operated in accordance with a Singapore Air Operator Certificate.

3.2 The operator shall provide for the use and guidance of maintenance and operational personnel concerned, a maintenance programme approved by the DGCA containing the information required below. The design and application of the operator's maintenance programme shall observe human factors principles. The maintenance programme shall include:

- (a) maintenance tasks and the intervals at which these are to be performed, taking into account the anticipated utilisation of the aeroplane;
- (b) when applicable, a continuing structural integrity programme;
- (c) procedures for changing and deviating from (a) and (b) above; and
- (d) when applicable condition monitoring and reliability programme descriptions for aircraft systems, components and powerplants. (Refer to Appendix 2).

Maintenance tasks and intervals that have been specified as mandatory in approval of the type design of the aircraft shall be identified as such.

3.3 The associated system of control over maintenance shall also include the following:

- (a) Servicing procedures for each aircraft type including:-
  - (i) Procedures for refuelling, defuelling and replenishment of oils, fluids and gases;
  - (ii) The approved specification and/or grade of fuel, oil, water methanol, hydraulic fluids, oxygen etc required for each aircraft type;

- (iii) The system of quality control to be observed by the operator in order that:
  - (A) petroleum products used in his aircraft conform with the approved specifications;
  - (B) work undertaken by other organisations and persons during the servicing of an aircraft is done correctly and safely; and
  - (C) adequate measures are taken by refuelling agencies to ensure the correct products are always supplied and that the likelihood of contamination and deterioration of petroleum products is minimal.

- (b) Policy for the use of manufacturers manuals and field service information.
- (c) Details of any reliability control programme or condition monitoring programme including a schedule of components or equipment subject to such programmes and the practices and procedures established for their use.

Note: Essential aspects are stated in Appendix 2 Chapter 4.3.

- (d) A minimum equipment list for each aircraft type including the conditions under which an unserviceable or inoperative component or equipment may be carried in service and the class of person who may certify that an aircraft may continue in service with an allowable unserviceable or inoperative component or equipment in accordance with the requirements of Chapter 4.10.
- (e) Procedures for applying to the CAAS for a concession or approval, of a change or variation, in compliance with a mandatory requirement or an approved maintenance schedule requirement.
- (f) The procedures to be observed for work undertaken on behalf of the operator by other organisations in Singapore or other countries; and, the procedures for certification of such work and issue of the necessary certificates.
- (g) The procedures for the use of aircraft components, equipment and materials in maintenance or other work when an aircraft is away from Singapore.

Note: Chapter 4.6 specifies the required records.

- (h) A list of all forms used in maintenance and other work plus a statement of their purposes and procedures for their use.

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## CHAPTER 4.3 : MAINTENANCE OF AIRCRAFT

### APPENDIX 1

# CERTIFICATE OF MAINTENANCE REVIEW

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

#### 1 General

- 1.1 Pursuant to paragraph 9 of the ANO, the issue of a CMR provides evidence that, at the date of issue, the aircraft was in compliance with the requirements of the maintenance schedule approved by the CAAS, that all modifications and inspections classified as mandatory had been satisfied, that defects entered in the technical log had been rectified or deferred in accordance with approved procedures and that all CRS had been issued in accordance with the Singapore Airworthiness Requirements. A copy of the current CMR must be carried on board the aircraft to which it relates.
- 1.2 CMR signatories work on behalf of approved organisations and as such, approved organisations must have procedures established as to how the signatory will comply with the requirement. For instance it may be acceptable for the signatory to accept authorised reports from various sections and rely on “no adverse comments” from quality audits, but he must have the right of access, questions and query to any relevant information, including quality audits, in order to carry out his task. It would be untenable if the signatory accepted reports without question from a reliability group if there were critical quality audits on that group of which he was not aware. In the absence of specific procedures, full access to all records will be required.
- 1.3 The CMR signatory shall be given access to such information as is necessary in order that he may carry out his obligations. It is therefore incumbent on the CMR signatory that he does research the records to the extent necessary to confidently issue the CMR. Thus the following records must be at his disposal: the maintenance schedule, the technical log, technical records and mandatory information like Airworthiness Directives.

#### 2 Aircraft above 2730 MTWA

In the case of aircraft above 2730 kg MTWA, the CMR shall be issued for a period of four calendar months unless a different period has been approved by the CAAS. Nothing prevents the CMR from being reissued as many times as necessary during each year, but its validity must never exceed four months or such period as approved by the CAAS. This flexibility of application of the CMR is intended to allow maintenance organisations to align its issue with an SMI if they wish to do so.

**3 Aircraft below 2730 MTWA**

In the case of aircraft below 2730 kg MTWA, the CMR shall be issued for a period of one year. Unless otherwise agreed or directed by the CAAS, the CMR must be aligned with the renewal of the Certificate of Airworthiness

**4 Conditions for Issue of CMR**

4.1 The signatory shall only issue a CMR when satisfied, at the time of the review, that the following aspects of maintenance have been carried out:

- (a) All maintenance requirements prescribed by the approved maintenance schedule, including requirements on all lified items and out-of-phase checks or similar special checks, have been complied with.
- (b) All mandatory modifications and inspections have been complied with within the prescribed time periods.
- (c) All entries in the technical log have been rectified or deferred in accordance with procedures approved by the CAAS.
- (d) All required CRSs have been issued.

4.2 The CMR shall be signed by the holder of an appropriate aircraft maintenance licence or a suitably authorised person of a maintenance organisation approved by the CAAS.

**5 Requirements for Applicants**

5.1 Persons seeking authorisations/approvals to issue Certificates of Maintenance Review shall:

- (a) hold an Aircraft Maintenance Engineer Licence in at least two categories under the SAR Section 7 appropriate to the aircraft type for which authorisation/approval is sought.; or
- (b) hold a SAR-66 Category B1 or B2 licence, with licence privileges equivalent to paragraph 5.1(a) appropriate to the aircraft type for which authorisation/approval is sought, : or
- (c) hold a full SAR-66 Category B1 or B2 licence appropriate to the aircraft type for which authorisation/approval is sought.
- (d) hold a foreign approved licence(s) with equivalent privilege(s) as the SAR approved licence(s) mentioned in paragraphs 5.1(a), (b) and (c), provided that the foreign requirements are determined by the DGCA to be acceptable.

- 5.2 Such person shall also:
- a) have at least eight years' experience of aircraft maintenance, which includes at least two years' recent experience involving the certification of maintenance; and
  - b) hold a position within the Approved Organisation compatible with the responsibilities involved; and
  - c) have successfully completed familiarisation training on the operator's requirements for which authorisation/approval is sought.
- 5.3 CMR certifying staff shall be trained in the procedures of the Organisation, and have passed the prescribed examinations and based upon the following:
- (i) The concept of Approval in accordance with Section 6 and other requirements prescribed by the DGCA.
  - (ii) The status of the Certificate of Maintenance Review and the responsibilities of a signatory of the Certificate.
  - (iii) The form and implementation of the Approved Maintenance Schedule for the type of aircraft concerned.
  - (iv) The details of the systems and procedures contained in the Exposition and associated documents, together with the requirements of the Organisation for their implementation.
  - (v) The maintenance support systems which are related to continuing airworthiness, e.g. reliability programmes, defect control, production control, development engineering, training, certification authority and modification control.
  - (vi) The form and use of the aircraft technical log, deferred defect log, fuel and instrument log, and the minimum equipment list.
  - (vii) The form and implementation of mandatory inspections/modifications as required by Airworthiness Directives (Mandatory Modification Inspections) for the type of aircraft concerned.
- 5.4 Persons seeking authorisations/approvals to issue Certificates of Maintenance Review for new aircraft, shall hold a SAR Section 7 licence in at least one category (except category "R") or a SAR-66 Category B licence appropriate to the aircraft type for which authorisation/approval is sought. In addition, the person shall comply with the requirements in paragraphs 5.2 to 5.3
- 5.5 For the purpose of paragraph 5.4, 'new aircraft' means a Singapore aircraft delivered new from the manufacturer, which has not yet been registered or operated in Singapore. The CMR for such new aircraft must be issued before its first flight as a Singapore aircraft.

**6 Validity of Authorisations/Approvals**

6.1 Authorisations/approvals granted in accordance with this Appendix shall only be used, subject to their conditions of validity, whilst the holder remains in the employ of the Approved Organisation and his licence remains valid.

**7 CERTIFICATE OF MAINTENANCE REVIEW**

A Certificate of Maintenance Review shall be issued at the times specified in the Approved Maintenance Schedule or the relevant Approval Document of the Maintenance Schedule, as appropriate. The certification shall be in the following format:

AIRCRAFT TYPE:	REGISTRATION:
INSPECTION RECORD REFERENCE:	
THIS MAINTENANCE REVIEW WAS CARRIED OUT ON:	
Certified that a maintenance review of this aircraft and such of its equipment as is necessary for its airworthiness has been carried out in accordance with the requirements of the Air Navigation Order for the time being in force.	
SIGNED:	
AUTHORISATION:	
DATE:	
The Next Maintenance Review is due on or before:	

**CHAPTER 4.3 : MAINTENANCE OF AIRCRAFT  
APPENDIX 2**

**RELIABILITY CONTROL PROGRAMMES**

EFFECTIVE DATE : 9 FEBRUARY 2015

REVISION NO : 21 (ISSUE 2)

- 1 Approval for the establishment of a reliability control programme and/or condition monitoring programme will be dependent on the operator submitting adequate details of the company policies and for administering such programmes.
- 2 The following aspects are essential and must be included in the submission:
  - (a) Programmes and their associated control systems must be directed by a board consisting of senior members of the operator who are responsible for engineering quality and maintenance and who will be responsible to establish company policy and procedures to co-ordinate all action within the company and to liaise with the DGCA on the initial approval and subsequent revisions to the programme, and surveillance of the programme.
  - (b) Responsibilities of each board member and their departments, and the responsibilities for co-ordination between the departments .
  - (c) The Information to be utilised for assessment of reliability.
  - (d) Policies for the establishment of levels of acceptable reliability for all components and equipment controlled by the programme.
  - (e) Procedures for selection of items to be included in the programme and schedule of the items that are controlled by the programme.
  - (f) Policies for monitoring and analysis of operational data, investigation of unsatisfactory performance and appropriate rectification action.
  - (g) Provision of forms and exhibits to ensure that all action is formally documented and to facilitate monitoring and surveillance of the programme.
  - (h) Provision for an EDTO reliability programme in accordance with SAR Chapter 4.11.

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## CHAPTER 4.5

# TECHNICAL LOGS

EFFECTIVE DATE : 9 FEBRUARY 2015  
REVISION NO : 21 (ISSUE 2)

### 1 General

This Chapter prescribes the requirements for Technical Logs required, pursuant to paragraph 9 of the Air Navigation Order, to be carried in Singapore aircraft.

### 2 Technical logs shall be provided by the owner or operator of an aircraft and shall contain the following information:

- (a) An identification that the document is a technical log required pursuant to the Air Navigation Order.
- (b) A list of the contents of the Log and directions for making the records unless such information is provided separately.
- (c) The name and address of the registered owner or operator.
- (d) The nationality and registration marks of the aircraft.
- (e) Instructions on how to defer defects. An aircraft or equipment defect can only be deferred in the following ways:
  - (i) The deferment is in accordance with the provision spelt out in the Minimum Equipment List (MEL).
  - (ii) The defect is related to a cabin item which is not safety-related.
  - (iii) The defect is allowed in the Maintenance Manual or Structural Repair Manual.
  - (iv) The deferment is pursuant to a Despatch Authorisation granted by the DGCA.
  - (v) The defect has incorporated an approved repair in accordance with the operator's procedures.
  - (vi) The deferment is otherwise in accordance with procedures approved by DGCA.
- (f) A record which shall have serially numbered sheets with provision for the following entries:
  - (i) The date and time at which each flight began and ended.

- (ii) Places and times of departure and arrival.
- (iii) Hours of flight.
- (iv) Certification for completion of all checks and inspections made in accordance with an approved maintenance schedule and which require certification by a nominated signatory.

Note: Such certifications must include the signature and licence, authorisation or approval reference of the persons and the date and time of certification.

- (v) Recording defects, failures, malfunctions or damage occurring to the aircraft, its components or equipment.
- (vi) The certification on a certificate of release to service by an appropriately licensed aircraft maintenance engineer or other authorised/approved person in respect of any work completed to rectify defects, failures, malfunctions or damage.
- (vii) In respect of the deferment of rectification of any defects, failures, malfunctions or allowable damage, a certification by an appropriately licensed aircraft maintenance engineer or other authorised/approved person recording the deferment and stating any conditions relevant to operation of the aircraft. The statement must refer to the relevant technical log entry.
- (g) The signature of the pilot-in-command of the aircraft.
- (h) A fuel and oil record which shall have serially numbered sheets with provision for the following entries:
  - (i) Date, time and place of refuelling.
  - (ii) The quantities of fuel, oil, water-methanol etc. uplifted and the quantities available in each tank or combination of tanks.
  - (iii) The grade of fuel, or other fluids, uplifted and its proprietary name and type of specification.
  - (iv) The measuring means used to determine the quantities of fuel in the aircraft after refuelling.

Note: The fuel & oil record may be provided as a separate document.

- 2A The owner or operator shall ascertain the trends for oil consumption are such that an aeroplane has sufficient oil to complete each flight.
- 2B The owner or operator shall retain the fuel and oil records for a minimum period of three months.

- 3 Entries in the technical log shall be made in ink or indelible pencil.
- 4 The record sheets shall be in duplicate with provision for a copy of each entry made to be retained by the operator at the place where the entry was made.
- 5 The original copy of maintenance and defect records shall be retained by the owner or operator for a period of two years following the expiry of any period of validity or the date of an entry.
- 6 Appropriate data shall be extracted and entered in the aircraft and engine log books or other approved records system as soon as possible after the conclusion of each flight or scheduled series of flights.

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## CHAPTER 4.6

# AIRCRAFT RECORDS SYSTEM

EFFECTIVE DATE : 1 JULY 2003

REVISION NO : 5 (ISSUE 2)

### 1 General

Pursuant to paragraph 15 of the Singapore Air Navigation Order, log books are required to be kept for aircraft, engines and variable pitch propellers.

This Chapter prescribes the records to be maintained in log books or other approved records systems in respect of:

- (a) The engineering history of aircraft, engines and propellers including components and equipment as applicable.
- (b) The maintenance completed.
- (c) Other work completed.
- (d) Defects, damage, failures or malfunctions that have occurred.
- (e) Airworthiness data.

2 The owner or operator of aircraft operated in accordance with an Air Operator Certificate approval may obtain approval to use a records system instead of the prescribed log books provided the system includes the required data and records, and procedures are established which will ensure that accurate records are maintained. A record of all important modifications and major repairs shall also be kept for each aircraft in an approved Modification Record Book.

3 The operator shall ensure that the following records are maintained for aircraft, engines and variable pitch propellers including their components and equipment for the periods specified in paragraph 4:

- (a) The total time in service and number of landings of the aircraft on a daily basis.
- (b) All maintenance checks or inspections completed in accordance with an approved maintenance schedule including the date and total time in service when the certifications were made.
- (c) All overhauls, repairs, replacements or modifications completed and the date and total time in service when the certifications were made.
- (d) Particulars of any defects, failures, malfunctions or damage occurring to the aircraft, its components and equipment, the rectification action taken and a reference to any relevant technical log entries.

- (e) The approved data or documents observed for all work other than that completed in accordance with approved maintenance schedules or approved work sheets.
- (f) Details of any concession approved for maintenance or other work.
- (g) Details of mandatory inspections completed including the results of such inspections.
- (h) The total time in service of aircraft components which are subject to a mandatory life limitations.
- (i) The time in service since new or overhaul as appropriate of any components or equipment which are subject to an approved overhaul period, a special check or inspection within a specified period.
- (j) The total time in service of major airframe components of complex aircraft.
- (k) The total time in service since new and the flight time since last overhaul of major components that have been replaced in the engines or propellers.
- (l) In respect of engines on which performance checks have been made such data which may be required during subsequent maintenance or operation.
- (m) The current status of compliance with all mandatory continuing airworthiness information.
- (n) A continuous record of the changes in empty weight and centre of gravity position due to modifications, repairs, alterations etc.
- (o) Detailed maintenance records to show that all requirements for the signing of the certificate of release to service have been met.

4 Records above are to be preserved for the following periods:

- (a) Paragraphs 3 (a) to (m) - a minimum period of 24 months after the date the aircraft or aircraft component has been destroyed or permanently withdrawn from service.
- (b) Paragraph 3 (n) - a period of time as per the requirement in paragraph 16(3) of the Air Navigation Order.
- (c) Paragraph 3 (o) - a minimum period of 2 years after the signing of the certificate of release to service. The certificate of release itself shall be preserved for a period of time as per the requirement in paragraph 10 (5) of the Air Navigation Order.

Note: (1) A person responsible for making an entry in a log book or other approved record may be required to substantiate any statements made in such records.

(2) Periods for retention for technical logs and fuel oil record is given in Chapter 4.5.

## CHAPTER 4.8

# REQUIRED INSPECTION AND TESTS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

Pursuant to paragraph 7 of the Air Navigation Order the DGCA may require an inspection or test to be made on an aircraft to determine whether it is airworthy. This Chapter prescribes the requirements to establish the airworthiness condition of an aircraft following:

- (a) The completion of maintenance involving the adjustment, repair, modification or replacement of any part of a control system or units of the flight, engine and propeller controls, their related system controls, and associated operating mechanisms. Duplicate inspections are required of all work which, if not completed correctly, could affect the safety of an aircraft.
- (b) The application of abnormal loads in flight or on the ground.
- (c) Modifications, repairs or replacements of components which may affect the accuracy of a magnetic compass or compass system.

### 2 Duplicate Inspection of Control Systems

Note: A duplicate inspection is an inspection first made and certified by one qualified person and then repeated and certified by a second qualified person.

The requirements are as follows:

- (a) Duplicate inspections shall be made and certified by appropriately licensed aircraft maintenance engineers or persons approved or authorised to undertake work on the particular control system.  
  
In an emergency and when only minor adjustments are involved the second inspection may be made and certified by a flight engineer or pilot licensed for the aircraft type (except a student).
- (b) Duplicate inspections of all affected control systems in an aircraft shall:-
  - (i) Be made after its assembly and before the first flight, and
  - (ii) Before flight after overhaul, repair, replacement or adjustments. Inspections may be limited to a specific section or part of a system when only a minor adjustment or minor work has been done.

- (c) The inspections shall be of sufficient depth to determine that the control system(s) have been installed and adjusted in accordance with the manufacturers requirements or other approved data or documents. The procedures shall be specified in an approved maintenance schedule or work-sheet (which for complex systems should include a check list of the necessary operations) and shall also ensure that full and correct movement of controls throughout the system(s) relative to movement of the flight crew's controls is obtained both prior to and after all covers and fairings are finally secured.
- (d) Control systems subject to duplicate inspections must not be disturbed or readjusted after the first inspection has been completed and certified. The second inspection must be made as early as practical after the first inspection but may be commenced before the first inspection is completed in areas where access is difficult or other similar problems exist.
- (e) Any disturbance of a control system after completion of a duplicate inspection will require further duplicate inspections and certifications of the part of the system that has been disturbed.
- (f) If a duplicate inspection is required, it shall be the final operation to establish the integrity of the system when all other work has been completed.
- (g) The approved worksheets or approved data for the overhaul and repair of sealed components shall, where appropriate, include procedures for:-
  - (i) Duplicate inspections and certifications of the sections/ parts which will be concealed during bench assembly and which cannot be proved to be functioning in accordance with the manufacturers requirements when subsequently installed on an aircraft; and
  - (ii) Duplicate inspections, of such units, after final assembly for functioning and correct relative movement.

The certification for these inspections shall be attached as part of the approved certificate for the component. The certifications shall be made by persons, whose names and duties are stated in the approved quality control system or company exposition.
- (h) Where it is not possible to make duplicate inspections of a complete system due to the routing of controls through inaccessible sections, the persons responsible for duplicate inspections may accept certifications for prior duplicate inspections of specific areas or for sealed units provided a certification of the earlier inspections is available and duplicate inspections of the accessible sections are made, the correct units are installed, the system functions in accordance with the manufacturer's requirements, and has full, free and correct directional movement. The certifications for all such duplicate inspections shall be attached as part of the final duplicate inspections.

**3 INSPECTION FOLLOWING ABNORMAL LOADS IN FLIGHT OR ON THE GROUND**

- 3.1 An aircraft that has been subject to abnormal loads or stresses in flight or on the ground shall be inspected in accordance with the requirements of the manufacturer or an approved maintenance schedule or worksheet prior to the next flight.
- 3.2 Such inspections shall be made by an appropriately licensed aircraft maintenance engineer. The results and a certification, of the inspections shall be entered in the log book or other approved records. A report of any damage and rectification action shall be submitted in accordance with Chapter 4.9.

**4 TESTING OF MAGNETIC COMPASSES**

- 4.1 Each magnetic compass on aircraft on which the undermentioned work has been completed shall be checked to determine whether the work has affected the accuracy of the compass(es). Where there is any indication of a change in accuracy a compass swing in accordance with an approved procedure in Chapter 3.7 shall be completed.
- (a) The replacement of an engine mounted in the forward fuselage or the installation, removal or replacement of any magnetic material which may affect the accuracy of a compass.
  - (b) The installation of a new electrical system or major modification to an existing system.
  - (c) The installation of geophysical survey equipment or other equipment likely to have a strong external magnetic field.
  - (d) The replacement of any component of a compass installation which may affect the accuracy of the installation.

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## CHAPTER 4.9

# MANDATORY REPORTS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

1.1 Pursuant to paragraph 88 of the Air Navigation Order the DGCA may require reports regarding the airworthiness condition of an aircraft to be made to him.

1.2 This Chapter prescribes the requirements for reporting the occurrence or detection of defects, failures or malfunctions in an aircraft, its components or equipment, which could jeopardize the safe operation of an aircraft or cause it to become a danger to persons or property.

2 Reports shall, as applicable, be submitted by:

- (a) The holder of an Air Operator Certificate, or the owner or operator of the aircraft, following the occurrence to their aircraft of a potentially hazardous defect, failure or malfunction detected during maintenance or other work on an aircraft.
- (b) Approved persons or organisations who during maintenance or other work become aware of serious or hazardous defects, failures or malfunctions on aircraft or aircraft components.
- (c) The holder of an Air Operator Certificate in respect of reportable occurrences during aircraft flight operations, as specified in the AOCR Appendix Q.
- (d) The holder of an Air Operator Certificate in the form of a periodical summary of technical delays, systems defects, failures or malfunctions, component premature removals, and investigations made by the holder into important technical problems.

3 Potentially hazardous occurrences referred to in Paragraph 2(a) are defects, failures or malfunctions of aircraft, components or equipment that result in:

- (a) Fire or operation of fire or smoke warning systems.
- (b) Significant leakage of fuel, oil or other fluid.
- (c) Smoke, vapour, toxic or noxious fumes inside the aircraft.
- (d) Malfunction, stiffness, slackness or reduced range of movement of any controls.
- (e) Incorrect assembly of components, causing possible malfunction.

- (f) Engine malfunction resulting in partial loss of power, engine shutdown.
- (g) Failure or malfunction of the thrust reverser system.
- (h) Failure of a propeller feathering system to shut down an engine or to control thrust.
- (i) Use of incorrect fuel, oil or other fluid.
- (j) Fuel system malfunction affecting fuel supply, distribution and jettison.
- (k) Fuel spillage on ground.
- (l) Significant failure or malfunction of electrical, instrument, hydraulic, pneumatic, flight control, pressurisation or ice protection systems or of the radio and navigation equipment.
- (m) On a multi-engine rotorcraft, loss of drive of one engine.
- (n) Operation of any rotorcraft transmission condition-warning system.
- (o) Failure of any required emergency equipment to operate or inadvertent operation that causes a hazardous situation.
- (p) Failure of aircraft primary structure.
- (q) Cracks, permanent deformation or corrosion of aircraft structure or major aircraft components that exceed specified limits, defects found as the result of a mandatory inspection.
- (r) Structural damage resulting from any cause which requires any permanent or temporary repair before the aircraft can fly.
- (s) Failure or malfunction of ground equipment used for testing/checking aircraft systems or equipment.
- (t) Any other occurrence that has jeopardised or may endanger the safe operation of an aircraft, or cause a danger to persons or property.

| 4 Defects, failures or malfunctions shall be reported to the DGCA in accordance with the following:

- | (a) Potentially hazardous occurrences specified in paragraph 3, within 72 hours of the occurrence or its detection or such other period acceptable to the DGCA.
- | (b) Statistical summaries of defects, failures, malfunctions and premature removals of components and equipment, within a period acceptable to the DGCA.

5 The reports shall be provided in an acceptable format, except that initial report made in accordance with paragraph 4(a) may be telephoned to the Airworthiness /

Flight Operations Division, Civil Aviation Authority of Singapore provided a written report is submitted within 72 hours. Reports shall include as much of the following data that is available at the time:

- (a) Aircraft type and registration marks.
- (b) Name of the operator or owner.
- (c) The date and the maintenance being performed when the defect, failure or malfunction occurred or was detected.
- (d) Any precautionary or emergency procedures used.
- (e) A description of the defect, failure or malfunction.
- (f) The identification of the component, equipment or system involved, including the make, serial number and part number(s) of the major component(s) involved.
- (g) The total time in service since new and/or overhaul and the time in service since the last maintenance on the items involved.
- (h) The apparent cause of the occurrence.
- (i) The action taken to rectify the defect, failure or malfunction and any action to preclude its recurrence.
- (j) Whether the aircraft was grounded.
- (k) Other pertinent information necessary for more complete identification, seriousness of the defect etc., corrective action taken etc.

6 Reports shall not be withheld because all the required information is not available.

7 When all the pertinent data is not available or the cause of the occurrence cannot be determined without further investigation a supplementary report shall be submitted detailing the missing data and any additional information that becomes available since the initial report such as:

- (a) The total number of flights since new if a primary structural component is affected.
- (b) Details of damage which indicates the pattern of sequence of failure.
- (c) A brief summary of any pertinent data that could assist in identification or determination of the seriousness, cause, associated effects of the occurrence.

8 Defective aircraft, components and equipment which are the subject of a report may be required to be available for investigation by the DGCA. Any such components or equipment removed from an aircraft shall not be despatched from Singapore, nor have any work commenced on them if it would impede any investigation without the prior approval from the DGCA.

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## CHAPTER 4.10

# MINIMUM EQUIPMENT LIST

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

- 1 Pursuant to paragraph 14 of the Air Navigation Order, DGCA may grant a permission permitting a Singapore aircraft to commence a flight in specified circumstances notwithstanding that any specified item of equipment required by the Air Navigation Order to be carried is not in a condition fit for use.
- 2 This Chapter prescribes the requirements for the preparation of Minimum Equipment Lists (MEL) that will specify the conditions under which, an aircraft can be authorised to continue in service with certain parts, components, equipment and systems inoperative or unserviceable, or with minor damage to, or missing airframe or engine parts of secondary importance. Each MEL shall be approved by the DGCA and copies shall be included in the flight crew operations manual. The MEL prepared by the operator shall not be less restrictive than the Master Minimum Equipment (MMEL) list approved by the State of Design for that aircraft type.
- 3 A minimum equipment list shall contain:
  - (a) A general preamble which states:
    - (i) The operator's basic policies regarding operation of an aircraft, components or equipment.
    - (ii) The pilot-in-command's responsibilities to report such defects or damage. The aspects to be considered by him in deciding whether to continue a flight without rectification action being taken.
    - (iii) The responsibilities of engineering staff regarding the deferment of rectification action and their notification and advice to the pilot-in-command.
    - (iv) The certifications required for the deferment of rectification action and notification within the company that a deferment has been authorised.
  - (b) A list of the items that may be unserviceable. The following shall be included for each item:
    - (i) The number installed per aircraft and the number and location of the items required to be serviceable in specific circumstances.
    - (ii) The limits and conditions applicable in authorising the deferment together with the notification and advice to flight crews of deferments.

- (iii) Any inspection or assessment required before an authorisation may be granted.
  - (iv) The rectification intervals within which of defects on specific items must be accomplished.
  - (v) Any limitations imposed on the operation of an aircraft with:
    - (a) unserviceable or inoperative, components, equipment, parts or systems.
    - (b) missing components or parts.
    - (c) minor damage.
- 4 The MEL shall indicate clearly items which have different dispatch requirements for ETOPS flights, in accordance with Chapter 4.11.
- 5 A list, or amendment to a list, submitted for approval must be accompanied with justification for the acceptance of each item which should include the following information:
- (a) The part number and manufacturer's name of each item, except where a complete system is involved.
  - (b) Evidence of prior approval by the State of Design, of a similar proposal e.g. Inclusion of the item in an approved master minimum equipment list or configuration deviation list etc.
  - (c) A statement of the effect an unserviceability will have on the airworthiness status and the operational status of the aircraft including the various classes of operations in which the aircraft may operate.
  - (d) In respect of amendments, a statement of the failure rate of each item submitted and any company action to improve its reliability.
  - (e) A statement that the company's flight operations and engineering departments have agreed on the proposed schedule or amendment.
- 6 Operation of an aircraft with either unserviceable or inoperative components or equipment that are not specified in a minimum equipment list, or damage exceeding that specified in the minimum equipment list may only be permitted by the DGCA, or senior officers of the operator authorised by the DGCA for this purpose. The powers of a delegation will be subject to specific limitations depending on the complexity of the aircraft involved, the technical and operational support which can be provided and the establishment of procedures detailing the conditions under which such permissions can be given.

## CHAPTER 4.11

# EXTENDED DIVERSION TIME OPERATIONS (EDTO)

EFFECTIVE DATE : 9 FEBRUARY 2015  
REVISION NO : 21 (ISSUE 2)

### 1 General

- 1.1 Pursuant to paragraph 29(5) of the Singapore Air Navigation Order, an operator of aeroplanes with two turbine engines shall comply with the following continuing airworthiness requirements in order to conduct extended diversion time operations (EDTO) where the diversion time exceeds the threshold time.

*Note : EDTO involving aeroplanes with two engines may be referred to as Extended Range Twin-Engine Operations (ETOPS).*

### 2 Type Design

- 2.1 The operator shall satisfy the DGCA that the particular airframe engine combination is EDTO certified.

*Note : The Type Design Approval for the aircraft does not reflect a continuing airworthiness or Operational Approval to conduct extended range operations. An Operational Approval for ETOPS operation has to be separately obtained from the DGCA.*

### 3 Operational Approval

- 3.1 An operator requesting a written permission for EDTO or an increase of the maximum diversion time shall submit an application, with the required supporting data, to the DGCA prior to the proposed start of EDTO with the specific airframe-engine combination. The operator shall submit the following:
- (a) Type Design Approval;
  - (b) In-service experience;
  - (c) Propulsion system reliability (operator and world fleet);
  - (d) Reliability of significant airframe system;
  - (e) Appropriate Auxiliary Power Unit (APU) in-flight start programme;
  - (f) Operator's Reliability and Maintenance Programmes;
  - (g) Conformance to latest Airworthiness Directives and Configurations, Maintenance and Procedures (CMP) standards;
  - (h) Training of maintenance personnel; and

(i) Any other data requested by the DGCA.

3.2 The operator shall demonstrate its ability and competence to maintain and operate the aeroplane so as to achieve the necessary reliability in extended diversion time operations.

#### **4 Configurations, Maintenance and Procedures**

4.1 The operator shall ensure that its EDTO fleet is in compliance with the latest CMP standards provided by the aeroplane manufacturer and the Type Certificate Authority.

4.2 The operator shall implement the CMP standards before the next EDTO flight or in accordance to a schedule accepted by the DGCA.

#### **5 Minimum Equipment List (MEL)**

5.1 The operator shall indicate clearly in the MEL of the EDTO fleet, items that have different dispatch requirements for EDTO flights. Systems considered to have a fundamental influence on flight safety shall include but are not limited to:

- (a) Electrical power.
- (b) Hydraulic system.
- (c) Pneumatic.
- (d) Flight instrumentation.
- (e) Fuel.
- (f) Flight control.
- (g) Ice protection.
- (h) Engine start and ignition.
- (i) Propulsion system instruments.
- (j) Navigation and communications.
- (k) Auxiliary power-units.
- (l) Air conditioning and pressurisation.
- (m) Cargo fire suppression.
- (n) Emergency equipment.
- (o) Engine fire detection and extinguishing systems.
- (p) Any other equipment required for extended diversion time operations.

**6 Aeroplane Dispatch**

- 6.1 The operator shall ensure that the aeroplane is precluded from being dispatched for EDTO when:
- (a) After an engine in-flight shut-down (IFSD) on a previous flight;
  - (b) After primary airframe system failure on a previous flight;
  - (c) After a replacement of an engine;
  - (d) After failure of an engine power control system or significant adverse trends in engine performance; or
  - (e) After any major maintenance works on the aircraft.
- 6.2 The aeroplane shall operate at least one non-revenue (handling flight) or non-EDTO revenue flight successfully before being released on extended diversion time operations. This shall be reflected in the aircraft technical log.

**7 APU In-flight Start Programme**

- 7.1 The operator shall establish maintenance procedures to verify in-flight start reliability following maintenance of the APU and APU components, as defined by the manufacturer, where start reliability at altitude may have been affected.
- 7.2 To ensure that the APU maintains its in-flight start capabilities, the operator shall have an appropriate APU in-flight programme. When APU in-flight starts are necessary to demonstrate the APU start reliability, the operator shall perform an APU in-flight start once every three months for each aircraft of its EDTO fleet. The result of the in-flight start shall be annotated in the Technical Log of the aircraft.

**8 Maintenance Training**

- 8.1 The operator shall have a maintenance training programme to ensure
- (a) personnel involved in EDTO are provided with the necessary training;
  - (b) personnel can accomplish the EDTO maintenance related tasks properly; and
  - (c) that the special nature of EDTO related maintenance requirements is emphasized.
- 8.2 For the purpose of this Chapter, EDTO qualified maintenance personnel are those that have completed the operators' EDTO training programme and have satisfactorily performed extended range tasks under supervision, within the framework of the operator's approved procedures for Personnel Authorisation.

**9 EDTO Parts Control**

- 9.1 The operator shall have an EDTO Parts Control Programme to ensure that the proper parts and configurations are maintained for EDTO fleets. The Programme shall include verification that parts placed on an EDTO aircraft during parts borrowing or pooling arrangements, as well as those parts used after repair or overhaul, maintain the necessary EDTO configuration for that aircraft.

**10 Maintenance Programme and Procedures**

- 10.1 The operator shall ensure that the airframe and propulsion systems continue to be maintained in accordance with the maintenance programme and at the level of performance and reliability necessary for extended diversion time operations. The operator shall ensure that the maintenance programme for its EDTO fleet contains the standards, guidance and direction necessary to support the intended operations. Maintenance personnel and other personnel involved shall be made aware of the special nature of EDTO and have the knowledge, skills and ability to accomplish the requirements of the programme.
- 10.2 The maintenance programme for the aeroplane being considered for EDTO is the continuous airworthiness maintenance schedule currently approved for the operator. The operator shall review the schedule to ensure that it provides an adequate basis for development of EDTO maintenance requirements. The programme shall incorporate human factors principles.
- 10.3 The operator shall have procedures to preclude identical action being applied to multiple similar elements in any EDTO significant system (e.g. fuel control change on both engines). If this is not possible, the identical actions shall be done by different maintenance personnel/teams.
- 10.4 The operator shall include in the maintenance procedures the following:
- (a) EDTO related tasks shall be identified on the operator's routine work forms and related instructions.
  - (b) EDTO related procedures, such as involvement of centralised maintenance control, shall be clearly defined in the operator's programme.
  - (c) An EDTO service check shall be developed to verify that the status of the aeroplane and certain critical items are acceptable. This check shall be accomplished and signed off by an EDTO qualified maintenance personnel immediately prior to an EDTO flight.
  - (d) Log books shall be reviewed and documented, as appropriate, to ensure proper MEL procedures, deferred items, maintenance checks and system verification procedures have been properly performed.
- 10.5 When the maintenance is contracted to a maintenance organisation, the operator shall ensure that the contractor complies with the EDTO requirements and procedures. The operator shall establish control procedures to ensure that:

- (a) The maintenance personnel of the contracted maintenance organisation are qualified for EDTO.
- (b) Additional maintenance requirements as identified in the operator's maintenance control manual are complied with.

## **11 EDTO Manual**

- 11.1 The operator shall develop an EDTO manual for use by personnel involved in such operations. This manual shall at least make reference to the maintenance programme and other requirements described in this chapter of the Singapore Airworthiness Requirements and clearly indicate where they are located in the operator's manual system.
- 11.2 All EDTO requirements, including supportive programmes, procedures, duties, and responsibilities, shall be identified and be subject to revision control. This manual shall be submitted to the DGCA for approval before the implementation of EDTO by the operator.

## **12 Oil Consumption Programme**

- 12.1 In addition to paragraph 3A of chapter 4.5 where the operator shall ascertain the trends for oil consumption, the operator shall have in place an oil consumption programme. The programme shall reflect the manufacturer's recommendations and be sensitive to oil consumption trends. It shall consider the amount of oil added at the departing EDTO stations with reference to the running average consumption; i.e. the monitoring must be continuous up to, and including, oil added at the EDTO departure station. If oil analysis is meaningful to this make and model, it shall be included in the programme. The APU oil consumption shall also be part of the oil consumption programme.

## **13 Engine Condition Monitoring**

- 13.1 The operator shall have an engine condition monitoring programme that describes the parameters to be monitored, method of data collection and corrective action process. The programme shall also incorporate the manufacturer's instructions and industry practice. This monitoring shall be used to detect deterioration at an early stage to allow for corrective action before safe operation is affected. The programme shall ensure that engine limit margins are maintained such that a prolonged single-engine diversion may be conducted without exceeding approved engine limits (i.e., rotor speeds, exhaust gas temperature) at all approved power levels and expected environmental conditions.
- 13.2 The monitoring programme shall include assessment of in-flight shut-down (IFSD) rate of the operator's EDTO fleet. The assessment shall include, as a minimum, engine hours flown in the period, in flight shut-down rate for all causes and engine removal rate, both on a 12 month moving average basis. When the IFSD rate exceeds 0.05/1000 engine hours for 120 minutes diversion time or exceeds 0.03/1000 engine hours for 180 minutes diversion time, the operator must notify the DGCA as soon as possible.

- 13.3 When any adverse sustained trend is noted, the operator shall in consultation with the DGCA, conduct an immediate evaluation to ascertain the causes. The evaluation may result in corrective action or operational restrictions being applied.

**14 Verification Programme after Maintenance**

- 14.1 The operator shall develop a verification programme or establish procedures to ensure corrective action following an engine shut-down, primary system failure or adverse trends, any prescribed events which require a verification flight or other action. The operator shall establish the means to assure the accomplishment of the verification programme or the corrective action procedures. A clear description of who must initiate verification actions and the section or group responsible for the determination of what action is necessary shall be identified in the programme. Primary systems or conditions requiring verification actions shall be described in the operator's EDTO manual.

**15 Reliability Programme**

- 15.1 An EDTO reliability programme shall be developed by the operator or the operator's existing reliability programme supplemented. This programme shall be designed with early identification and prevention of EDTO related problems as the primary goal. The programme shall be event-orientated and incorporate reporting procedures for significant events detrimental to EDTO flights. This information shall be readily available for use by the DGCA to help establish that the reliability level is adequate, and to assess the operators competence and capability to safely continue EDTO. The DGCA shall be notified within 72 hours of events reportable through this programme.

**16 Reporting**

- 16.1 In addition to the items required to be reported as per Section 4 Chapter 4.9 of the SAR, the following items shall be included:
- (a) In-flight shut-downs;
  - (b) Diversion or turn-back;
  - (c) Uncommand power changes or surges;
  - (d) Inability to control the engine or obtain desired power;
  - (e) Unscheduled removal of engines;
  - (f) Problems with systems critical to EDTO; and
  - (g) Any other events detrimental to EDTO.

16.2 The report shall identify the following:

- (a) Aeroplane Registration;
- (b) Engine identification (position, make and serial number);
- (c) Total time, cycles and time since last shop visit;
- (d) For systems, time since overhaul or last inspection of the defective unit;
- (e) Phase of flight; and
- (f) Corrective action.

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## CHAPTER 4.12

# FLIGHT RECORDERS

EFFECTIVE DATE : 11 JANUARY 2017

REVISION NO : 25 (ISSUE 2)

### 1 Introduction

1.1 Pursuant to paragraph 37, and paragraphs 4(5), 4(6) and 4(7) of the Fifth Schedule of the Air Navigation Order, this chapter prescribes the requirements of, and the parameters to be recorded by, flight recorders.

- (a) Paragraph 2 of this chapter lists the requirements for aeroplanes to which paragraphs 4(5) and 4(6) of the Fifth Schedule of the ANO apply.
- (b) Paragraph 3 of this chapter lists the requirements for helicopters to which paragraph 4(7) of the Fifth Schedule of the ANO applies.
- (c) The operator, or owner as the case may be, of a Singapore aircraft shall ensure that the aircraft is equipped with the flight recorders in accordance with the requirements specified in this chapter.
- (d) The operator, or owner as the case may be, of a Singapore aircraft shall ensure that the flight recorders installed on the aircraft are maintained and operated in accordance with the requirements specified in the ANO and this chapter.

### 1.2 Flight recorders

*Note 1 : Crash protected flight recorders comprise one or more of the following systems: a flight data recorder (FDR), a cockpit voice recorder (CVR), an airborne image recorder (AIR) and/or a data link recorder (DLR). Image and data link information may be recorded on either the CVR or the FDR.*

*Note 2 : Lightweight flight recorders, applicable for aeroplanes, comprise one or more of the following systems: an aircraft data recording system (ADRS), a cockpit audio recording system (CARS), an airborne image recording system (AIRS) and/or a data link recording system (DLRS). Image and data link information may be recorded on either the CARS or the ADRS.*

*Note 3 : Combination recorders (FDR/CVR) may be used to meet the flight recorder equipage requirements for helicopters in this chapter.*

*Note 4 : Details on flight recorders are contained in Appendices 1 and 2 for aeroplanes and helicopters respectively.*

**2 Requirements for aeroplanes**

**2.1 Flight data recorders and aircraft data recording systems.**

*Note 1 : FDR and AIR performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

*Note 2 : ADRS performance requirements are as contained in the EUROCAE ED-155, Minimum Operational Performance Specification (MOPS) for Lightweight Flight Recorder Systems, or equivalent documents.*

**(a) Types**

- (1) Types I and IA FDRs shall record the parameters required to determine accurately the aeroplane's flight path, speed, attitude, engine power, configuration and operation.
- (2) Types II and IIA FDRs shall record the parameters required to determine accurately the aeroplane flight path, speed, attitude, engine power and configuration of lift and drag devices.
- (3) Parameters to be recorded for Types I, IA, and II FDRs are specified in Appendix 1 and listed in Table 1.
- (4) Parameters to be recorded for ADRS are specified in Appendix 1 and listed in Table 4.

**(b) Applicability**

*Note : Airborne image recorders (AIRs) classification is defined in paragraph 4.1 of Appendix 1.*

- (1) Any aeroplane of a MTWA of more than 5700 kg for which the certificate of airworthiness was first issued on or before 1 January 2005 shall be equipped with a Type I FDR
- (2) Any aeroplane of a MTWA of more than 5700 kg for which the certificate of airworthiness was first issued after 1 January 2005 shall be equipped with a Type IA FDR.
- (3) An aeroplane, with 2 or more turbine engines, of a MTWA of 5700 kg or less for which the certificate of airworthiness was first issued on or after 1 January 1990 shall be equipped with a Type IIA FDR.

- (4) Notwithstanding sub-paragraph (3), any turbine-engined aeroplane, which is operating for the purpose of public transport, of a MTWA of 5700 kg or less for which the certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with:
- (i) a Type II FDR; or
  - (ii) a Class C AIR capable of recording flight path and speed parameters displayed to the pilot(s); or
  - (iii) an ADRS capable of recording the essential parameters defined in Table 4.
- (5) Notwithstanding sub-paragraph (3), any turbine-engined aeroplane, which is operating for a purpose other than public transport, of a MTWA of 5700 kg or less for which the application for type certification is submitted to a Contracting State on or after 1 January 2016 shall be equipped with:
- (i) a Type II FDR; or
  - (ii) a Class C AIR capable of recording flight path and speed parameters displayed to the pilot(s); or
  - (iii) an ADRS capable of recording the essential parameters defined in Table 4.

*Note : “The application for type certification is submitted to a Contracting State” refers to the date of application for the original “Type Certificate” for the aeroplane type and not the date of certification of particular aeroplane variants or derivative models.*

- (6) Any aeroplane for which the application for type certification is submitted to a Contracting State on or after 1 January 2016 which:
- (i) is operating for the purpose of public transport;
  - (ii) is required to record normal acceleration, lateral acceleration and longitudinal acceleration; and
  - (iii) is required to be equipped with an FDR
- shall record those parameters referred to in sub-paragraph (ii) at a maximum sampling and recording interval of 0.0625 seconds.
- (7) Any aeroplane for which the application for type certification is submitted to a Contracting State on or after 1 January 2016 which:
- (i) is required to record pilot input and/or control surface position of primary controls (pitch, roll, yaw); and

- (ii) is required to be equipped with an FDR

shall record those parameters referred to in sub-paragraph (i) at a maximum sampling and recording interval of 0.125 seconds.

*Note : For an aeroplane with control systems in which movement of a control surface will back drive the pilot's control, "or" applies. For an aeroplane with control systems in which movement of a control surface will not back drive the pilot's control, "and" applies. In an aeroplane with independent moveable surfaces, each surface needs to be recorded separately. In an aeroplane with independent pilot input on primary controls, each pilot input on primary controls needs to be recorded separately.*

(c) **Discontinuation**

- (1) The following are not permitted:

- (i) the use of engraving metal foil FDRs.
- (ii) the use of analogue FDRs using frequency modulation (FM).
- (iii) the use of photographic film FDRs.

- (2) The use of magnetic tape FDRs shall be discontinued by 1 January 2016.

(d) **Duration**

A FDR shall be capable of retaining the information recorded during at least the last 25 hours of its operation, except for the Type IIA FDR which shall be capable of retaining the information recorded during at least the last 30 minutes of its operation.

(e) **Operations**

- (1) An FDR, AIR or ADRS shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power.
- (2) In addition, depending on the availability of electrical power, the AIR, if installed, must start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.

## 2.2 Cockpit voice recorders and cockpit audio recording systems

*Note 1 : CVR performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

*Note 2: CARS performance requirements are as contained in the EUROCAE ED-155, Minimum Operational Performance Specification (MOPS) for Lightweight Flight Recorder Systems, or equivalent documents.*

### (a) Applicability

- (1) Any aeroplane with a MTWA exceeding 5700 kg shall be equipped with a CVR.
- (2) Any aeroplane, with a MTWA of 5700 kg or less which is operating for the purpose of public transport shall be equipped with either a CVR or a CARS if :
  - (i) it is power by turbine engine;
  - (ii) its certificate of airworthiness is first issued on or after 1 January 2016; and
  - (iii) it is required to be operated by more than one pilot.
- (3) Any aeroplane, with a MTWA 5700 kg or less which is operating for a purpose other than public transport shall be equipped with either a CVR or a CARS if :
  - (i) it is power by turbine engine;
  - (ii) the application for its type certification is submitted to the Contracting State on or after 1 January 2016; and
  - (iii) it is required to be operated by more than one pilot.

### (b) Discontinuation

- (1) The use of magnetic tape and wire CVRs shall be discontinued by 1 January 2016.

### (c) Duration

- (1) Any CVR installed on any aeroplane for which a CVR is required to be installed shall be capable of retaining the information recorded during at least the last two hours of its operation.
- (2) Any CVR installed on any aeroplane with a MTWA exceeding 27000kg for which the individual certificate of airworthiness is first issued on or after January 2021, shall be capable of retaining information recorded during at least the last twenty-five hours of its operation.

(d) **Operations**

- (1) The CVR and CARS shall start to record prior to the aeroplane moving under its own power and record continuously until the termination of the flight when the aeroplane is no longer capable of moving under its own power. In addition, depending on the availability of electrical power, the CVR and CARS shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.
- (2) The CVR and CARS shall record the signals specified in paragraph 3.1 of Appendix 1.

(e) **Alternate Power**

- (1) Any aeroplane of a MTWA of over 27,000 kg for which the application for type certification is submitted to a Contracting State on or after 1 January 2018 shall be provided with an alternate power source, as defined in sub-paragraph (2) below, that powers the CVR, in the case of combination recorders the forward CVR, and its associated cockpit area microphone components.
- (2) The alternate power source shall automatically engage and provide ten minutes, plus or minus one minute, of operation whenever aeroplane power to the recorder ceases, either by normal shutdown or by any other loss of power.
- (3) The CVR shall be located as close as practicable to the alternate power source.

*Note 1: "Alternate" means separate from the power source that normally provide power to the CVR. The use of aeroplane batteries or other power sources is acceptable provided that the requirements above are met and electrical power to essential and critical loads is not compromised.*

*Note 2: When the CVR function is combined with other recording functions within the same unit, powering the other functions is allowed.*

**2.3 Data link recorders**

*Note: Data link recorders performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

(a) **Applicability**

- (1) Any aeroplane for which the certificate of airworthiness is first issued on or after 1 January 2016, which utilize any of the data

link communications applications listed in paragraph 5.1(b) of Appendix 1 and is required to carry a CVR, shall record on a flight recorder the data link communications messages.

- (2) Any aeroplane which is modified on or after 1 January 2016 to install and utilize any of the data link communications applications listed in paragraph 5.1(b) of Appendix 1 and is required to carry a CVR shall record on a flight recorder the data link communications messages.

*Note 1: Data link communications are currently conducted by either ATN-based or FANS I/A-equipped aircraft.*

*Note 2: A Class B AIR could be a means for recording data link communications applications messages to and from the aeroplanes where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.*

(b) **Duration**

The minimum recording duration shall be equal to the duration of the CVR.

(c) **Correlation**

Data link recording shall be able to be correlated to the recorded cockpit audio.

2.4 **Flight recorders — general**

(a) **Construction and installation**

Flight recorders shall be constructed, located and installed so as to provide maximum practical protection for the recordings in order that the recorded information may be preserved, recovered and transcribed. Flight recorders shall meet the prescribed crashworthiness and fire protection specifications.

*Note 1: Industry crashworthiness and fire protection specifications for FDR, CVR, AIR and DLR are as contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

*Note 2: Industry crashworthiness and fire protection specifications for ADRS and CARS are as contained in the EUROCAE ED-155, Minimum Operational Performance Specifications (MOPS) for Lightweight Flight Recorder Systems, or equivalent documents.*

(b) **Continued serviceability**

- (1) Operational checks and evaluations of recordings from the flight recorder systems shall be conducted to ensure the continued serviceability of the recorders.

*Note: Procedures for the inspections of the flight recorder systems are given in Appendix 1.*

(c) **Flight recorder electronic documentation**

*The documentation requirement concerning FDR and ADRS parameters provided by operators to accident investigation authorities shall be in an electronic format, acceptable to the accident investigation authorities, and take account of industry specifications.*

*Note: Industry specification for documentation concerning flight recorder parameters may be found in the ARINC 647A, Flight Recorder Electronic Documentation, or equivalent document.*

(d) **Combination recorders**

- (1) Any aeroplane is operating for the purpose of public transport:
  - (i) which is of a MTWA of over 5700 kg;
  - (ii) for which the application for type certification is submitted to a Contracting State on or after 1 January 2016; and
  - (iii) which is required to be equipped with both a CVR and an FDR,

shall be equipped with two combination recorders (FDR/CVR). In addition, for any aeroplane with a MTWA of over 15,000 kg, one recorder shall be located as close to the cockpit as practicable and the other recorder located as far aft as practicable.

- (2) Any aeroplane of a MTWA over 5700 kg, and which is required to be equipped with an FDR and a CVR, may alternatively be equipped with two combination recorders (FDR/CVR).

*Note: The requirement in this paragraph may be satisfied by equipping the aeroplanes with two combination recorders (one forward and one aft) or separate devices.*

- (3) An aeroplane, with 2 or more turbine engines, of a MTWA of 5700 kg or less, and which is required to be equipped with an FDR and/or a CVR, may alternatively be equipped with one combination recorder (FDR/CVR).

**2.5 Flight recorders — data recovery**

- 2.5.1 An operator of an aeroplane that is required to be equipped in accordance with Scale FF in paragraph 5 of the Fifth Schedule of the ANO shall seek the DGCA's approval for the means to recover flight data and make it available in a timely manner.
- 2.5.2 To support the application under paragraph 2.5.1, the operator shall provide at least the following information:
- (a) the capabilities of the operator;
  - (b) overall capability of the aeroplane and its systems as certified by State of Design;
  - (c) the reliability of the means to recover the appropriate CVR channels and appropriate FDR data: and
  - (d) specific mitigation measures.

**3 Requirements for helicopters****3.1 Flight data recorders and aircraft data recording systems**

*Note 1: FDR and AIR performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

*Note 2: ADRS performance requirements are as contained in the EUROCAE ED-155, Minimum Operational Performance Specification (MOPS) for Lightweight Flight Recorder Systems, or equivalent documents.*

**(a) Types**

- (1) A Type IV FDR shall record the parameters required to determine accurately the helicopter flight path, speed, attitude, engine power and operation.
- (2) A Type IVA FDR shall record the parameters required to determine accurately the helicopter flight path, speed, attitude, engine power, operation and configuration.
- (3) A Type V FDR shall record the parameters required to determine accurately the helicopter flight path, speed, attitude and engine power.
- (4) Parameters to be recorded by Types IV, IVA and V FDRs are specified in Appendix 2 and listed in Table 2.
- (5) Parameters to be recorded by ADRS are specified in Appendix 2 and listed in Table 5.

(b) **Applicability**

- (1) Any helicopter of a MTWA of over 7000 kg, or having a passenger seating configuration of more than 19, for which the individual certificate of airworthiness was first issued on or after 1 January 1989 shall be equipped with a Type IV FDR.
- (2) Any helicopter of a MTWA of more than 3175 kg but not more than 7000 kg, for which the individual certificate of airworthiness was first issued on or after 1 January 1989, shall be equipped with a Type V FDR.
- (3) Notwithstanding sub-paragraphs (1) and (2), any helicopter of a MTWA of over 3175 kg for which the individual certificate of airworthiness is first issued on or after 1 January 2016 shall be equipped with a Type IVA FDR
- (4) Any turbine-engine helicopters of MTWA over 2250 kg, up to and including 3175 kg for which the application for type certification was submitted to a Contracting State on or after 1 January 2018 shall be equipped with:
  - (i) a Type IVA FDR; or
  - (ii) a Class C AIR capable of recording flight path and speed parameters displayed to the pilot(s); or
  - (iii) an ADRS capable of recording the essential parameters defined in Table 5.

(c) **Discontinuation**

- (1) The following are not permitted:
  - (i) use of engraving metal foil FDRs .
  - (ii) use of photographic film FDRs
  - (iii) use of analogue FDRs using frequency modulation (FM)
- (2) The use of magnetic tape FDRs shall be discontinued by 1 January 2016.

(d) **Duration**

Types IV, IVA and V FDRs shall be capable of retaining the information recorded during at least the last ten hours of their operation.

(e) **Operations**

- (1) The FDR, and/or AIR if installed, shall start to record prior to the helicopter moving under its own power and record continuously until the termination of the flight when the helicopter is no longer capable of moving under its own power.

- (2) In addition, depending on the availability of electrical power, the AIR if installed shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.

### 3.2 Cockpit voice recorders

*Note: CVR performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) or Crash Protected Airborne Recorder Systems, or equivalent documents.*

#### (a) Applicability

- (1) Any helicopter for which the certificate of airworthiness was first issued on or after 1 January 1987 shall be equipped with a CVR so long as it has a MTWA of over 3175 kg. In the case of a helicopter which is not equipped with an FDR, at least the main rotor speed shall be recorded on the CVR.
- (2) Any helicopter for which the certificate of airworthiness was first issued before 1 January 1987 shall be equipped with a CVR so long as it has a MTWA of over 7000 kg. For a helicopter which is not equipped with an FDR, at least main rotor speed shall be recorded on the CVR.

#### (b) Discontinuation

- (1) The use of magnetic tape and wire CVRs shall be discontinued by 1 January 2016.

#### (c) Duration

- (1) Any CVR installed on a helicopter for which a CVR is required to be installed shall be capable of retaining the information recorded during the last two hours of its operation.

#### (d) Operations

The CVR shall start to record prior to the helicopter moving under its own power and record continuously until the termination of the flight when the helicopter is no longer capable of moving under its own power. In addition, depending on the availability of electrical power, the CVR shall start to record as early as possible during the cockpit checks prior to engine start at the beginning of the flight until the cockpit checks immediately following engine shutdown at the end of the flight.

### 3.3 Data link recorders

*Note :* Data link recorders performance requirements are as contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.

#### (a) Applicability

- (1) Any helicopter for which the individual certificate of airworthiness is first issued on or after 1 January 2016, which utilizes any of the data link communications applications listed in paragraph 5.1(b) of Appendix 2 and is required to carry a CVR shall record, on a flight recorder, all the data link communications messages.
- (2) Any helicopter which is modified on or after 1 January 2016 to install and utilize any of the data link communications applications listed in paragraph 5.1(b) of Appendix 2 and is required to carry a CVR, shall record, on a flight recorder the data link communications messages.

*Note 1 :* Data link communications are currently conducted by either ATN-based or FANS 1/A-equipped helicopter.

*Note 2 :* A Class B AIR could be a means for recording data link communications applications messages to and from the helicopters where it is not practical or is prohibitively expensive to record those data link communications applications messages on FDR or CVR.

#### (b) Duration

The minimum recording duration shall be equal to the duration of the CVR.

#### (c) Correlation

Data link recording shall be able to be correlated to the recorded cockpit audio.

### 3.4 Flight recorders — general

#### (a) Construction and installation

Flight recorders shall be constructed, located and installed so as to provide maximum practical protection for the recordings in order that the recorded information may be preserved, recovered and transcribed. Flight recorders shall meet the prescribed crashworthiness and fire protection specifications.

*Note :* Industry crashworthiness and fire protection specifications are as contained in the EUROCAE ED-112, Minimum Operational

*Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

**(b) Continued serviceability**

- (1) Operational checks and evaluations of recordings from the flight recorder systems shall be conducted to ensure the continued serviceability of the recorders.

*Note :* Procedures for the inspections of the flight recorder systems are given in Appendix 2.

**(c) Flight recorder electronic documentation**

The documentation requirement concerning FDR parameters provided by operators to accident investigation authorities shall be in an electronic format, acceptable to the accident investigation authority, and take account of industry specifications.

*Note:* Industry specification for documentation concerning flight recorder parameters may be found in the ARINC 647A, Flight Recorder Electronic Documentation, or equivalent document.

**4 Automatic deployable flight recorder (ADFR)**

**4.1 Operation**

The following requirements shall apply to an ADFR:

- (a) deployment shall take place when the aeroplane structure has been significantly deformed;
- (b) deployment shall take place when an aeroplane sinks in water;
- (c) ADFR shall not be capable of manual deployment;
- (d) the ADFR shall be able to float on water;
- (e) the ADFR deployment shall not compromise the safe continuation of the flight;
- (f) the ADFR deployment shall not significantly reduce the chance of survival of the recorder and of successful transmission by its ELT;
- (g) the ADFR deployment shall not release more than one piece;
- (h) an alert shall be made to the flight crew when the ADFR is no longer captive to the aircraft;
- (i) the flight crew shall have no means to disable ADFR deployment when the aircraft is airborne;

- (j) the ADFR shall contain an integrated ELT, which shall activate automatically during the deployment sequence. Such ELT may be of a type that is activated in-flight and provides information from which a position can be determined; and
- (k) the integrated ELT of an ADFR shall satisfy the same requirements as an ELT required to be installed on an aeroplane. The integrated ELT shall at least have the same performance as the fixed ELT to maximize detection of the transmitted signal.

*Note: Refer to the Manual on Location of Aircraft in Distress and Flight Recorder Data Recovery (ICAO Doc 10054) for more information on ADFR.*

**Table 1**  
**Parameters to be recorded by**  
**Crash Protected Flight Data Recorders – Types I, IA, and II**

<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR read-out)</i>	<i>Recording resolution</i>
1	Time (UTC when available, otherwise relative time count or GPS time sync)	24 hours	4	±0.125% per hour	1 second
2	Pressure-altitude	–300 m (–1 000 ft) to maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	±30 m to ±200 m (±100 ft to ±700 ft)	1.5 m (5 ft)
3	Indicated airspeed or calibrated airspeed	95 km/h (50 kt) to max $V_{So}$ (Note 1) $V_{So}$ to 1.2 $V_D$ (Note 2)	1	±5%□ ±3%	1 kt (0.5 kt recommended)
4	Heading (primary flight crew reference)	360°	1	±2°	0.5°
5	Normal acceleration (Note 3)	–3 g to +6 g	0.125	±1% of maximum range excluding datum error of ±5%	0.004 g
6	Pitch attitude	±75° or usable range whichever is greater	0.25	±2°	0.5°
7	Roll attitude	±180°	0.25	±2°	0.5°
8	Radio transmission keying	On-off (one discrete)	1		
9	Power on each engine (Note 4)	Full range	1 (per engine)	±2%	0.2% of full range or the resolution required to operate the aircraft
10*	Trailing edge flap and cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft
11*	Leading edge flap and cockpit control selection	Full range or each discrete position	2	±5% or as pilot's indicator	0.5% of full range or the resolution required to operate the aircraft
12*	Thrust reverser position	Stowed, in transit, and reverse	1 (per engine)		
13*	Ground spoiler/speed brake selection (selection and position)	Full range or each discrete position	1	±2% unless higher accuracy uniquely required	0.2% of full range
14	Outside air temperature	Sensor range	2	±2°C	0.3°C
15*	Autopilot/auto throttle/AFCS mode and engagement status	A suitable combination of discrettes	1		

<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR read-out)</i>	<i>Recording resolution</i>
16	Longitudinal acceleration (Note 3)	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
<i>Note.— The preceding 16 parameters satisfy the requirements for a Type II FDR.</i>					
17	Lateral acceleration (Note 3)	±1 g	0.25	0.015 g excluding a datum error of ±0.05 g	0.004 g
18	Pilot input and/or control surface position-primary controls (pitch, roll, yaw) (Note 5) (Note 6)	Full range	0.25	±2° unless higher accuracy uniquely required	0.2% of full range or as installed
19	Pitch trim position	Full range	1	±3% unless higher accuracy uniquely required	0.3% of full range or as installed
20*	Radio altitude	−6 m to 750 m (−20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)	0.3 m (1 ft) below 150 m (500 ft.)  0.3 m (1 ft) +0.5% of full range above 150 m (500 ft)
21*	Vertical beam deviation (ILS/GPS/GLS glide path, MLS elevation, IRNAV/IAN vertical deviation)	Signal range	1	±3%	0.3% of full range
22*	Horizontal beam deviation (ILS/GPS/GLS localizer, MLS azimuth, IRNAV/IAN lateral deviation)	Signal range	1	±3%	0.3% of full range
23	Marker beacon passage	Discrete	1		
24	Master warning	Discrete	1		
25	Each NAV receiver frequency selection (Note 7)	Full range	4	As installed	
26*	DME 1 and 2 distance (includes Distance to runway threshold (GLS) and Distance to missed approach point (IRNAV/IAN)) (Notes 7 and 8)	0 – 370 km (0 – 200 NM)	4	As installed	1852 m (1 NM)
27	Air/ground status	Discrete	1		
28*	TAWS/GCAS status (selection of terrain display mode including pop-up display status) and (terrain alerts, both cautions and warnings, and advisories) and (on/off switch position)	Discrete	1		
29*	Angle of attack	Full range	0.5	As installed	0.3 % of full range
30*	Hydraulics, each system (low pressure)	Discrete	2		0.5% of full range

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<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR read-out)</i>	<i>Recording resolution</i>
31*	Navigation data (latitude/longitude, ground speed and drift angle) <i>(Note 9)</i>	As installed	1	As installed	
32*	Landing gear and gear selector position	Discrete	4	As installed	
<i>Note.— The preceding 32 parameters satisfy the requirements for a Type I FDR.</i>					
33*	Groundspeed	As installed	1	Data should be obtained from the most accurate system	1 kt
34	Brakes (left and right brake pressure, left and right brake pedal position)	(Maximum metered brake range, discretises or full range)	1	± 5%	2% of full range
35*	Additional engine parameters (EPR, N <sub>1</sub> , indicated vibration level, N <sub>2</sub> , EGT, fuel flow, fuel cut-off lever position, N <sub>3</sub> )	As installed	Each engine each second	As installed	2% of full range
36*	TCAS/ACAS (traffic alert and collision avoidance system)	Discretises	1	As installed	
37*	Windshear warning	Discrete	1	As installed	
38*	Selected barometric setting (pilot, co-pilot)	As installed	64	As installed	0.1 hPa (0.003 in-Hg)
39*	Selected altitude (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
40*	Selected speed (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
41*	Selected Mach (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine
42*	Selected vertical speed (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
43*	Selected heading (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
44*	Selected flight path (all pilot selectable modes of operation) (course/DSTRK, path angle, final approach path (IRNAV/IAN))		1	As installed	
45*	Selected Decision Height	As installed	64	As installed	Sufficient to determine crew selection
46*	EFIS display format (pilot, co-pilot)	Discrete(s)	4	As installed	

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<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR read-out)</i>	<i>Recording resolution</i>
47*	Multi-function/engine/alerts display format	Discrete(s)	4	As installed	
v48*	AC electrical bus status	Discrete(s)	4	As installed	
49*	DC electrical bus status	Discrete(s)	4	As installed	
50*	Engine bleed valve position	Discrete(s)	4	As installed	
51*	APU bleed valve position	Discrete(s)	4	As installed	
52*	Computer failure	Discrete(s)	4	As installed	
53*	Engine thrust command	As installed	2	As installed	
54*	Engine thrust target	As installed	4	As installed	2% of full range
55*	Computed centre of gravity	As installed	64	As installed	1% of full range
56*	Fuel quantity in CG trim tank	As installed	64	As installed	1% of full range
57*	Head up display in use	As installed	4	As installed	
58*	Para visual display on/off	As installed	1	As installed	
59*	Operational stall protection, stick shaker and pusher activation	As installed	1	As installed	
60*	Primary navigation system reference (GNSS, INS, VOR/DME, MLS, Loran C, localizer glideslope)	As installed	4	As installed	
61*	Ice detection	As installed	4	As installed	
62*	Engine warning each engine vibration	As installed	1	As installed	
63*	Engine warning each engine over temperature	As installed	1	As installed	
64*	Engine warning each engine oil pressure low	As installed	1	As installed	
65*	Engine warning each engine over speed	As installed	1	As installed	
66*	Yaw Trim Surface Position	Full range	2	± 3% unless higher accuracy uniquely required	0.3% of full range
67*	Roll Trim Surface Position	Full range	2	± 3% unless higher accuracy uniquely required	0.3% of full range
68*	Yaw or sideslip angle	Full range	1	± 5%	0.5°
69*	De-icing and/or anti-icing systems selection	Discrete(s)	4		

<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR read-out)</i>	<i>Recording resolution</i>
70*	Hydraulic pressure (each system)	Full range	2	± 5%	100 psi
71*	Loss of cabin pressure	Discrete	1		
72*	Cockpit trim control input position Pitch	Full range	1	± 5%	0.2% of full range or as installed
73*	Cockpit trim control input position Roll	Full range	1	± 5%	0.2% of full range or as installed
74*	Cockpit trim control input position Yaw	Full range	1	± 5%	0.2% of full range or as installed
75*	All cockpit flight control input forces (control wheel, control column, rudder pedal)	Full range (±311 N (±70 lbf), ± 378 N (±85 lbf), ± 734 N (±165 lbf))	1	± 5%	0.2% of full range or as installed
76*	Event marker	Discrete	1		
77*	Date	365 days	64		
78*	ANP or EPE or EPU	As installed	4	As installed	

*Note.*— The preceding 78 parameters satisfy the requirements for a Type IA FDR.

*Notes.*—

1.  $V_{S0}$  stalling speed or minimum steady flight speed in the landing configuration.
2.  $V_D$  design diving speed.
3. Refer to paragraph 2.1(b)(6) of the chapter for increased recording requirements.
4. Record sufficient inputs to determine power.
5. For aeroplanes with control systems in which movement of a control surface will back drive the pilot's control, "or" applies. For aeroplanes with control systems in which movement of a control surface will not back drive the pilot's control, "and" applies. In aeroplanes with split surfaces, a suitable combination of inputs is acceptable in lieu of recording each surface separately.
6. Refer to paragraph 2.1(b)(7) of the chapter for increased recording requirements.
7. If signal available in digital form.

8. Recording of latitude and longitude from INS or other navigation system is a preferred alternative.
9. If signals readily available.

If further recording capacity is available, recording of the following additional information should be considered:

- a) operational information from electronic display systems, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS). Use the following order of priority:
  - 1) parameters selected by the flight crew relating to the desired flight path, e.g. barometric pressure setting, selected altitude, selected airspeed, decision height, and autoflight system engagement and mode indications if not recorded from another source;
  - 2) display system selection/status, e.g. SECTOR, PLAN, ROSE, NAV, WXR, COMPOSITE, COPY, ETC.;
  - 3) warnings and alerts;
  - 4) the identity of displayed pages for emergency procedures and checklists;
- b) retardation information including brake application for use in the investigation of landing overruns and rejected take-offs.

**Table 2**  
**Parameters to be recorded by**  
**Flight Data Recorders – Types IV, IVA and V**

<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR readout)</i>	<i>Recording resolution</i>
1	Time (UTC when available, otherwise relative time count or GPS time sync)	24 hours	4	±0.125% per hour	1 s
2	Pressure altitude	maximum certificated altitude of aircraft +1 500 m (+5 000 ft)	1	±30 m to ±200 m (±100 ft to ±700 ft)	1.5 m (5 ft)
3	Indicated airspeed	As the installed pilot display measuring system	1	±3%	1 kt
4	Heading	360°	1	±2°	0.5°
5	Normal acceleration	-3 g to +6 g	0.125	±0.09 g excluding a datum error of ±0.045 g	0.004 g
6	Pitch attitude	±75° or 100% of useable range whichever is greater	0.5	±2°	0.5°
7	Roll attitude	±180°	0.5	±2°	0.5°
8	Radio transmission keying	On-off (one discrete)	1	—	—
9	Power on each engine	Full range	1 (per engine)	±2%	0.1% of full range
10	Main rotor:				
	Main rotor speed	50–130%	0.51	±2%	0.3% of full range
	Rotor brake	Discrete		—	—
11	Pilot input and/or control surface position — primary controls (collective pitch, longitudinal cyclic pitch, lateral cyclic pitch, tail rotor pedal)	Full range	0.5 (0.25 recommended)	±2% unless higher accuracy uniquely required	0.5% of operating range
12	Hydraulics, each system (low pressure and selection)	Discrete	1	—	—
13	Outside air temperature	Sensor range	2	±2°C	0.3°C
14*	Autopilot/ autothrottle/ AFCS mode and engagement status	A suitable combination of discretely	1	—	—
15*	Stability augmentation system engagement	Discrete	1	—	—

*Note.*— The preceding 15 parameters satisfy the requirements for a Type V FDR.

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<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR readout)</i>	<i>Recording resolution</i>
16*	Main gearbox oil pressure	As installed	1	As installed	6.895 kN/m <sup>2</sup> (1 psi)
17*	Main gearbox oil temperature	As installed	2	As installed	1°C
18	Yaw rate	±400°/second	0.25	±1.5% maximum range excluding datum error of ±5%	±2°/s
19*	Sling load force	0 to 200% of certified load	0.5	±3% of maximum range	0.5% for maximum certified load
20	Longitudinal acceleration	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
21	Lateral acceleration	±1 g	0.25	±0.015 g excluding a datum error of ±0.05 g	0.004 g
22*	Radio altitude	−6 m to 750 m (−20 ft to 2 500 ft)	1	±0.6 m (±2 ft) or ±3% whichever is greater below 150 m (500 ft) and ±5% above 150 m (500 ft)	0.3 m (1 ft) below 150 m (500 ft), 0.3 m (1 ft) + 0.5% of full range above 150 m (500 ft)
23*	Vertical beam deviation	Signal range	1	±3%	0.3% of full range
24*	Horizontal beam deviation	Signal range	1	±3%	0.3% of full range
25	Marker beacon passage	Discrete	1	—	—
26	Warnings	Discrete(s)	1	—	—
27	Each navigation receiver frequency selection	Sufficient to determine selected frequency	4	As installed	—
28*	DME 1 and 2 distances	0–370 km (0–200 NM)	4	As installed	1 852 m (1 NM)
29*	Navigation data (latitude/longitude, ground speed, drift angle, wind speed, wind direction)	As installed	2	As installed	As installed
30*	Landing gear or and gear selector position	Discrete	4	—	—
<i>Note.— The preceding 30 parameters satisfy the requirements for a Type IV FDR.</i>					
31*	Engine exhaust gas temperature (T <sub>4</sub> )	As installed	1	As installed	
32*	Turbine inlet Temperature (TIT/ITT)	As installed	1	As installed	
33*	Fuel contents	As installed	4	As installed	
34*	Altitude rate	As installed	1	As installed	
35*	Ice detection	As installed	4	As installed	

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<i>Serial number</i>	<i>Parameter</i>	<i>Measurement range</i>	<i>Maximum sampling and recording interval (seconds)</i>	<i>Accuracy limits (sensor input compared to FDR readout)</i>	<i>Recording resolution</i>
36*	Helicopter health and usage monitor system	As installed	—	As installed	—
37	Engine control modes	Discrete	1	—	—
38*	Selected barometric setting (pilot and co-pilot)	As installed	64 (4 recommended)	As installed	0.1 hPa (0.003 in-Hg)
39*	Selected altitude (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
40*	Selected speed (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
41*	Selected Mach (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
42*	Selected vertical speed (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
43*	Selected heading (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
44*	Selected flight path (all pilot selectable modes of operation)	As installed	1	As installed	Sufficient to determine crew selection
45*	Selected decision height	As installed	4	As installed	Sufficient to determine crew selection
46*	EFIS display format (pilot and co-pilot)	Discrete(s)	4	—	—
47*	Multifunction/ engine/ alerts display format	Discrete(s)	4	—	—
48*	Event marker	Discrete	1	—	—

*Note.— The preceding 48 parameters satisfy the requirements for a Type IVA FDR.*

**Table 3**  
**Description of Applications for Data Link Recorders**

Item No.	Application Type	Application Description	Recording Content
1	Data link Initiation	This includes any applications used to logon to or initiate data link service. In FANS-1/A and ATN, these are ATS Facilities Notification (AFN) and Context Management (CM) respectively.	C
2	Controller/Pilot Communication	This includes any application used to exchange requests, clearances, instructions and reports between the flight crew and controllers on the ground. In FANS-1/A and ATN, this includes the CPDLC application. It also includes applications used for the exchange of oceanic (OCL) and departure clearances (DCL) as well as data link delivery of taxi clearances.	C
3	Addressed Surveillance	This includes any surveillance application in which the ground sets up contracts for delivery of surveillance data. In FANS-1/A and ATN, this includes the Automatic Dependent Surveillance (ADS-C) application. Where parametric data are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	C
4	Flight Information	This includes any service used for delivery of flight information to specific aircraft. This includes, for example, D-METAR, D-ATIS, D-NOTAM and other textual data link services.	C
5	Aircraft Broadcast Surveillance	This includes Elementary and Enhanced Surveillance Systems, as well as ADS-B output data. Where parametric data sent by the aeroplane are reported within the message they shall be recorded unless data from the same source are recorded on the FDR.	M *
6	Aeronautical Operational Control Data	This includes any application transmitting or receiving data used for AOC purposes (per the ICAO definition of AOC).	M *

## Key:

C: Complete contents recorded.

M: Information that enables correlation to any associated records stored separately from the aircraft.

\*: Applications to be recorded only as far as is practicable given the architecture of the system.

**Table 4**  
**Parameters to be recorded by Aircraft Data Recording Systems on**  
**Aeroplanes**

N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
1	Heading (Magnetic or True)	R*	±180 degrees	1	±2 degrees	0.5 degree	* If not available, record rates
2	Pitch attitude	E*	±90 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rates
3	Roll attitude	E*	±180 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rates
4	Yaw rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no heading available
5	Pitch rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no pitch attitude available
6	Roll rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no roll attitude available
7	Positioning system: latitude/longitude	E	Latitude:± 90 degrees Longitude:± 180 degrees	2 (1 if available)	As installed (0.00015 degree recommended)	0.00005 degree	
8	Positioning system estimated error	E*	Available range	2 (1 if available)	As installed	As installed	* If available
9	Positioning system: altitude	E	-300 m (-1 000 ft) to maximum certificated altitude of aeroplane +1 500 m (5 000 ft)	2 (1 if available)	As installed (±15 m (±50 ft) recommended)	1.5 m (5 ft)	
10	Positioning system: time*	E	24 hours	1	±0.5 second	0.1 second	* UTC time preferred where available.
11	Positioning system: ground speed	E	0 - 1000 kt	2 (1 if available)	As installed (±5 kt recommended)	1 kt	
12	Positioning system: channel	E	0 - 360 degrees	2 (1 if available)	As installed (± 2 degrees recommended)	0.5 degrees	
13	Normal acceleration	E	- 3 g to + 6 g (*)	0.25 (0.125 if available)	As installed (± 0.09 g excluding a datum error of ±0.45 g recommended)	0.004 g	
14	Longitudinal acceleration	E	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of	0.004 g	

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N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
					±0.05 g recommended)		
15	Lateral acceleration	E	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
16	External static pressure (or pressure altitude)	R	34.4 hPa (1.02 in-Hg) to 310.2 hPa (9.16 in-Hg) or available sensor range	1	As installed (±1 hPa (0.03 in-Hg) or ±30 m (±100 ft) to ±210 m (±700 ft) recommended - refer to table IIA. 2)	0.1 hPa (0.003 in-Hg) or 1.5 m (5 ft)	
17	Outside air temperature (or total air temperature)	R	-50° to +90°C or available sensor range	2	As installed (±2°C recommended)	1°C	
18	Indicated air speed	R	As the installed Pilot display measuring system or available sensor range	1	As installed (±3 % recommended)	1 kt (0.5 kt recommended)	
19	Engine RPM	R	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	
20	Engine oil pressure	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
21	Engine oil temperature	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
22	Fuel flow or pressure	R	Full range	Each engine each second	As installed	2% of full range	
23	Manifold pressure	R	Full range	Each engine each second	As installed	0.2% of full range	
24	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	R	Full range	Each engine each second	As installed	0.1% of full range	* Sufficient parameters e.g. EPR/N1 or torque/Np as appropriate to the particular engine shall be recorded to determine power in both normal and reverse thrust. A margin for

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N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
							possible overspeed should be provided.
25	Engine gas generator speed (Ng)	R	0-150%	Each engine each second	As installed	0.2% of full range	
26	Free power turbine speed (Nf)	R	0-150%	Each engine each second	As installed	0.2% of full range	
27	Coolant temperature	R	Full range	1	As installed (±5°C recommended)	1 degree celsius	
28	Main voltage	R	Full range	Each engine each second	As installed	1 Volt	
29	Cylinder head temperature	R	Full range	Each engine each second	As installed	2% of full range	
30	Flaps position	R	Full range or each discrete position	2	As installed	0.5 degree	
31	Primary flight control surface position	R	Full range	0.25	As installed	0.2 % of full range	
32	Fuel quantity	R	Full range	4	As installed	1% of full range	
33	Exhaust gas temperature	R	Full range	Each engine each second	As installed	2% of full range	
34	Emergency voltage	R	Full range	Each engine each second	As installed	1 Volt	
35	Trim surface position	R	Full range or each discrete position	1	As installed	0.3 % of full range	
36	Landing gear position	R	Each discrete position*	Each gear every two seconds	As installed		* Where available, record up-and-locked and down-and-locked position
37	Novel/unique aircraft features	R	As required	As required	As installed	As required	

**Key:**

E: Essential parameters

R: Recommended parameters

**Table 5  
Parameters to be recorded by Aircraft Data Recording Systems  
on Helicopters**

N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
1	Heading (Magnetic or True)	R*	±180 degrees	1	±2 degrees	0.5 degree	* If not available, record rotational rates
2	Pitch attitude	E*	±90 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rotational rates
3	Roll attitude	E*	±180 degrees	0.25	±2 degrees	0.5 degree	* If not available, record rotational rates
4	Yaw rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no heading available
5	Pitch rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no pitch attitude available
6	Roll rate	E*	±300 degrees/s	0.25	±1% + drift of 360°/hr	2 degree/s	* Essential if no roll attitude available
7	Positioning system: latitude/longitude	E	Latitude:± 90 degrees Longitude:± 180 degrees	2 (1 if available)	As installed (0.00015 degree recommended)	0.00005 degree	
8	Positioning system estimated error	E*	Available range	2 (1 if available)	As installed	As installed	* If available
9	Positioning system: altitude	E	-300 m (-1 000 ft) to maximum certificated altitude of aeroplane +1 500 m (5 000 ft)	2 (1 if available)	As installed (±15 m (±50 ft) recommended)	1.5 m (5 ft)	
10	Positioning system: time*	E	24 hours	1	±0.5 second	0.1 second	* UTC time preferred where available.
11	Positioning system: ground speed	E	0 - 1000 kt	2 (1 if available)	As installed (±5 kt recommended)	1 kt	
12	Positioning system: channel	E	0 - 360 degrees	2 (1 if available)	As installed (± 2 degrees recommended)	0.5 degrees	
13	Normal acceleration	E	- 3 g to + 6 g (*)	0.25 (0.125 if available)	As installed (± 0.09 g excluding a datum error of ±0.45 g recommended)	0.004 g	

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N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
14	Longitudinal acceleration	E	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
15	Lateral acceleration	E	±1 g (*)	0.25 (0.125 if available)	As installed (±0.015 g excluding a datum error of ±0.05 g recommended)	0.004 g	
16	External static pressure (or pressure altitude)	R	34.4 hPa (1.02 in-Hg) to 310.2 hPa (9.16 in-Hg) or available sensor range	1	As installed (±1 hPa (0.03 in-Hg) or ±30 m (±100 ft) to ±210 m (±700 ft) recommended)	0.1 hPa (0.003 in-Hg) or 1.5 m (5 ft)	
17	Outside air temperature (or total air temperature)	R	-50° to +90°C or available sensor range	2	As installed (±2°C recommended)	1°C	
18	Indicated air speed	R	As the installed Pilot display measuring system or available sensor range	1	As installed (±3 % recommended)	1 kt (0.5 kt recommended)	
19	Main rotor speed (Nr)	R	50% to 130% or available sensor range	0.5	As installed	0.3% of full range	
20	Engine RPM (*)	R	Full range including overspeed condition	Each engine each second	As installed	0.2% of full range	* for piston engine helicopters
21	Engine oil pressure	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
22	Engine oil temperature	R	Full range	Each engine each second	As installed (5% of full range recommended)	2% of full range	
23	Fuel flow or pressure	R	Full range	Each engine each second	As installed	2% of full range	
24	Manifold pressure	R	Full range	Each engine each second	As installed	0.2% of full range	* for piston engine helicopters

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N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
25	Engine thrust/power/torque parameters required to determine propulsive thrust/power*	R	Full range	Each engine each second	As installed	0.1% of full range	* Sufficient parameters e.g. EPR/N1 or torque/Np as appropriate to the particular engine shall be recorded to determine power in both normal and reverse thrust. A margin for possible overspeed should be provided.  Only for turbine engine helicopters
26	Engine gas generator speed (Ng) (*)	R	0-150%	Each engine each second	As installed	0.2% of full range	* Only for turbine engine helicopters
27	Free power turbine speed (Nf) (*)	R	0-150%	Each engine each second	As installed	0.2% of full range	* Only for turbine engine helicopters
28	Collective pitch	R	Full range	0.5	As installed	0.1% of full range	
29	Coolant temperature (*)	R	Full range	1	As installed (±5°C recommended)	1 degree celsius	* Only for piston engine helicopters
30	Main voltage	R	Full range	Each engine each second	As installed	1 Volt	
31	Cylinder head temperature (*)	R	Full range	Each engine each second	As installed	2% of full range	* Only for piston engine helicopters
32	Fuel quantity	R	Full range	4	As installed	1% of full range	
33	Exhaust gas temperature	R	Full range	Each engine each second	As installed	2% of full range	
34	Emergency voltage	R	Full range	Each engine each second	As installed	1 Volt	
35	Trim surface position	R	Full range or each discrete position	1	As installed	0.3 % of full range	
36	Landing gear position	R	Each discrete position*	Each gear every two seconds	As installed		* Where available, record up-and-locked and down-and-locked position

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N°	Parameter name	Parameter Category	Minimum Recording Range	Maximum recording interval in seconds	Minimum Recording Accuracy	Minimum Recording Resolution	Remarks
37	Novel/unique aircraft features	R	As required	As required	As installed	As required	

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**Key:**

E: Essential parameters

R: Recommended parameters

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## CHAPTER 4.12: FLIGHT RECORDERS APPENDIX 1

# FLIGHT RECORDERS FOR AEROPLANES

EFFECTIVE DATE : 30 JUNE 2016  
REVISION NO : 23 (ISSUE 2)

The material in this Appendix concerns flight recorders intended for installation in aeroplanes registered in Singapore. Crashed protected flight recorders comprise one or more of the following systems: a flight data recorder (FDR), a cockpit voice recorder (CVR), an airborne image recorder (AIR) and/or a data link recorder (DLR). Lightweight flight recorders comprise one or more of the following systems, an aircraft data recording system (ADRS), a cockpit audio recording system (CARS), an airborne image recording system (AIRS) and/or a data link recording system (DLRS).

### 1 General requirements

- 1.1 The flight recorder containers shall:
- (a) be painted a distinctive orange or yellow colour;
  - (b) carry reflective material to facilitate their location; and
  - (c) have securely attached an automatically activated underwater locating device operating at a frequency of 37.5kHz and, by no later than 31 December 2016, be capable of operating for a minimum of 90 days.
- 1.2 The flight recorder systems shall be installed so that:
- (a) the probability of damage to the recordings is minimized;
  - (b) they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorder systems without jeopardizing service to essential or emergency loads;
  - (c) there is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and
  - (d) if the flight recorder systems have a bulk erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact.
- 1.3 The flight recorder systems, when tested by methods approved by the appropriate certificating authority, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- 1.4 Means shall be provided for an accurate time correlation between the flight recorder systems recordings.

- 1.5 The manufacturer shall provide the appropriate certificating authority with the following information in respect of the flight recording systems:
- (a) manufacturer's operating instructions, equipment limitations and installation procedures;
  - (b) parameter origin or source and equations which relate counts to units of measurement; and
  - (c) manufacturer's test reports.

## **2 Flight data recorder (FDR)**

### **2.1 Parameters to be recorded**

- (a) Flight data recorders shall be classified as Type I, Type IA, Type II and Type IIA depending upon the number of parameters to be recorded and the duration required for retention of the recorded information.
- (b) The parameters that satisfy the requirements for FDRs are listed in the paragraphs below. The number of parameters to be recorded shall depend on aeroplane complexity. The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of aeroplane complexity. In addition, the parameters designated by an asterisk (\*) shall be recorded if an information data source for the parameter is used by aeroplane systems or the flight crew to operate the aeroplane. However, other parameters may be substituted with due regard to the aeroplane type and the characteristics of the recording equipment.
  - (1) The following parameters shall satisfy the requirements for flight path and speed:
    - Pressure altitude
    - Indicated airspeed or calibrated airspeed
    - Air-ground status and each landing gear air-ground sensor when practicable
    - Total or outside air temperature
    - Heading (primary flight crew reference)
    - Normal acceleration
    - Lateral acceleration
    - Longitudinal acceleration (body axis)
    - Time or relative time count
    - Navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
    - Groundspeed\*
    - Radio altitude\*

- (2) The following parameters shall satisfy the requirements for attitude:
- Pitch attitude
  - Roll attitude
  - Yaw or sideslip angle\*
  - Angle of attack\*
- (3) The following parameters shall satisfy the requirements for engine power:
- Engine thrust/power: propulsive thrust/power on each engine, cockpit thrust/power lever position
  - Thrust reverse status\*
  - Engine thrust command\*
  - Engine thrust target\*
  - Engine bleed valve position\*
  - Additional engine parameters\*: EPR, N1, indicated vibration level, N2, EGT, TLA, fuel flow, fuel cut-off lever position, N3
- (4) The following parameters shall satisfy the requirements for configuration:
- Pitch trim surface position
  - Flaps\*: trailing edge flap position, cockpit control selection
  - Slats\*: leading edge flap (slat) position, cockpit control selection
  - Landing gear\*: landing gear, gear selector position
  - Yaw trim surface position\*
  - Roll trim surface position\*
  - Cockpit trim control input position pitch\*
  - Cockpit trim control input position roll\*
  - Cockpit trim control input position yaw\*
  - Ground spoiler and speed brake\*: Ground spoiler position, ground spoiler selection, speed brake position, speed brake selection
  - De-icing and/or anti-icing systems selection\*
  - Hydraulic pressure (each system)\*
  - Fuel quantity in CG trim tank\*
  - AC electrical bus status\*
  - DC electrical bus status\*
  - APU bleed valve position\*
  - Computed centre of gravity\*

- (5) The following parameters shall satisfy the requirements for operation:
- Warnings
  - Primary flight control surface and primary flight control pilot input: pitch axis, roll axis, yaw axis
  - Marker beacon passage
  - Each navigation receiver frequency selection
  - Manual radio transmission keying and CVR/FDR synchronization reference
  - Autopilot/autothrottle/AFCS mode and engagement status\*
  - Selected barometric setting\*: pilot, first officer
  - Selected altitude (all pilot selectable modes of operation)\*
  - Selected speed (all pilot selectable modes of operation)\*
  - Selected Mach (all pilot selectable modes of operation)\*
  - Selected vertical speed (all pilot selectable modes of operation)\*
  - Selected heading (all pilot selectable modes of operation)\*
  - Selected flight path (all pilot selectable modes of operation)\*: course/DSTRK, path angle
  - Selected decision height\*
  - EFIS display format\*: pilot, first officer
  - Multi-function/engine/alerts display format\*
  - GPWS/TAWS/GCAS status\*: selection of terrain display mode including pop-up display status, terrain alerts, both cautions and warnings, and advisories, on/off switch position
  - Low pressure warning\*: hydraulic pressure, pneumatic pressure
  - Computer failure\*
  - Loss of cabin pressure\*
  - TCAS/ACAS (traffic alert and collision avoidance system/ airborne collision avoidance system)\*
  - Ice detection\*
  - Engine warning each engine vibration\*
  - Engine warning each engine over temperature\*
  - Engine warning each engine oil pressure low\*
  - Engine warning each engine over speed\*
  - Wind shear warning\*
  - Operational stall protection, stick shaker and pusher activation\*
  - All cockpit flight control input forces\*: control wheel, control column, rudder pedal cockpit input forces
  - Vertical deviation\*: ILS glide path, MLS elevation, GNSS approach path
  - Horizontal deviation\*: ILS localizer, MLS azimuth, GNSS approach path
  - DME 1 and 2 distances\*
  - Primary navigation system reference\*: GNSS, INS, VOR/DME, MLS, Loran C, ILS
  - Brakes\*: left and right brake pressure, left and right brake pedal position
  - Date\*
  - Event marker\*
  - Head up display in use\*
  - Para visual display on\*

*Note 1: Parameter guidance for range, sampling, accuracy and resolution, are as contained in the EUROCAE ED-112, Minimum Operational Performance Specification (MOPS) for*

*Crash Protected Airborne Recorder Systems, or equivalent documents.*

*Note 2: It is not intended that aeroplanes issued with an individual certificate of airworthiness before 1 January 2016 be modified to meet the range, sampling, accuracy or resolution guidance detailed in this Appendix and Tables.*

- (6) Type IA FDR. This FDR shall be capable of recording, as appropriate to the aeroplane, at least the 78 parameters in Table 1.
- (7) Type I FDR. This FDR shall be capable of recording, as appropriate to the aeroplane, at least the first 32 parameters in Table 1.
- (8) Types II and IIA FDRs. These FDRs shall be capable of recording, as appropriate to the aeroplane, at least the first 16 parameters in Table 1.
- (9) The parameters that satisfy the requirements for flight path and speed as displayed to the pilot(s) are listed below. The parameters without an (\*) are mandatory parameters which shall be recorded. In addition, the parameters designated by an (\*) shall be recorded if an information source for the parameter is displayed to the pilot and is practicable to record:
  - Pressure altitude
  - Indicated airspeed or calibrated airspeed
  - Heading (primary flight crew reference)
  - Pitch attitude
  - Roll attitude
  - Engine thrust/power
  - Landing-gear status\*
  - Total or outside air temperature\*
  - Time\*
  - Navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
  - Radio altitude\*

## 2.2 Additional information

- (a) A Type IIA FDR, in addition to a 30-minute recording duration, shall retain sufficient information from the preceding take-off for calibration purposes.
- (b) The measurement range, recording interval and accuracy of parameters on installed equipment shall be verified by methods approved by the appropriate certificating authority.
- (c) Documentation concerning parameter allocation, conversion equations, periodic calibration and other service-ability/maintenance information shall be maintained by the operator. The documentation needs to be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

**3 Cockpit voice recorder (CVR) and cockpit audio recording system (CARS)**

3.1 Signals to be recorded

- (a) The CVR shall record on four separate channels, or more, at least the following:
  - (1) voice communication transmitted from or received in the aeroplane by radio;
  - (2) aural environment on the flight deck;
  - (3) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed;
  - (4) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and
  - (5) voice communication of flight crew members using the passenger address system, if installed.
- (b) The CARS shall record on two separate channels, or more, at least the following:
  - (1) voice communication transmitted from or received in the aeroplane by radio;
  - (2) aural environment on the flight deck; and
  - (3) voice communication of flight crew members on the flight deck using the aeroplane's interphone system, if installed.
- (c) The CVR shall be capable of recording on at least four channels simultaneously. On a tape-based CVR, to ensure accurate time correlation between channels, the CVR is to record in an in-line format. If a bi-directional configuration is used, the in-line format and channel allocation shall be retained in both directions.
- (d) The preferred channel allocation shall be as follows:
  - Channel 1 - co-pilot headphones and live boom microphone
  - Channel 2 - pilot headphones and live boom microphone
  - Channel 3 - area microphone
  - Channel 4 - time reference plus the third and fourth crew members' headphone and live microphone, if applicable.

*Note 1: Channel 1 is located closest to the base of the recording head.*

*Note 2: The preferred channel allocation presumes use of current conventional magnetic tape transport mechanisms, and is*

*specified because the outer edges of the tape have a higher risk of damage than the middle. It is not intended to preclude use of alternative recording media where such constraints may not apply.*

#### **4 Airborne image recorder (AIR)**

##### **4.1 Classes**

- (a) A Class A AIR captures the general cockpit area in order to provide data supplemental to conventional flight recorders.

*Note 1: To respect crew privacy, the cockpit area view may be designed as far as practical to exclude the head and shoulders of crew members whilst seated in their normal operating position.*

*Note 2: There are no provision for Class A AIRs in this document.*

- (b) A Class B AIR captures data link message displays.
- (c) A Class C AIR captures instruments and control panels.

*Note : A Class C AIR may be considered as a means for recording flight data where it is not practical or is prohibitively expensive to record on an FDR, or where an FDR is not required.*

#### **5 Data link recorder (DLR)**

##### **5.1 Applications to be recorded**

- (a) Where the aircraft flight path is authorized or controlled through the use of data link messages, all data link messages, both uplinks (to the aircraft) and downlinks (from the aircraft), shall be recorded on the aircraft. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall be recorded.

*Note: Sufficient information to derive the content of the data link communications message and the time the messages were displayed to the flight crew is needed to determine an accurate sequence of events on board the aircraft.*

- (b) Messages applying to the applications listed below shall be recorded. Applications without the asterisk (\*) are mandatory applications which shall be recorded regardless of the system complexity. Applications with an (\*) shall be recorded only as far as is practicable given the architecture of the system.
- Data link initiation capability
  - Controller – pilot data link communications
  - Data link – flight information services
  - Automatic dependent surveillance – contract
  - Automatic dependent surveillance – broadcast\*

- Aeronautical operational control\*

*Note: Descriptions of the applications are contained in Table 3.*

## **6 Aircraft data recording systems (ADRS)**

### **6.1 Parameters to be recorded**

ADRS shall be capable of recording, as appropriate to the aeroplane, at least the essential (E) parameters in Table 4.

### **6.2 Additional information**

- (a) The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.
- (b) Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator. The documentation needs to be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

## **7 Inspections of flight recorder systems**

7.1 Prior to the first flight of the day, the built-in test features for the flight recorders and Flight Data Acquisition Unit (FDAU), when installed, shall be monitored by manual and/or automatic checks.

7.2 Annual inspections shall be carried out as follows:

- (a) an analysis of the recorded data from the flight recorders shall ensure that the recorder operates correctly for the nominal duration of the recording;
- (b) the analysis of the FDR shall evaluate the quality of the recorded data to determine if the bit error rate (including those introduced by recorder, the acquisition unit, the source of the data on the aeroplane and by the tools used to extract the data from the recorder) is within acceptable limits and to determine the nature and distribution of the errors;
- (c) a complete flight from the FDR shall be examined in engineering units to evaluate the validity of all recorded parameters. Particular attention shall be given to parameters from sensors dedicated to the FDR. Parameters taken from the aircraft's electrical bus system need not be checked if their serviceability can be detected by other aircraft systems;
- (d) the readout facility shall have the necessary software to accurately convert the recorded values to engineering units and to determine the status of discrete signals;

- (e) an annual examination of the recorded signal on the CVR shall be carried out by replay of the CVR recording. While installed in the aircraft, the CVR shall record test signals from each aircraft source and from relevant external sources to ensure that all required signals meet intelligibility standards;
  - (f) where practicable, during the annual examination, a sample of in-flight recordings of the CVR shall be examined for evidence that the intelligibility of the signal is acceptable; and
  - (g) an annual examination of the recorded images on the AIR shall be carried out by replay of the AIR recording. While installed in the aircraft, the AIR shall record test images from each aircraft source and from relevant external sources to ensure that all required images meet recording quality standards.
- 7.3 Flight recorder systems shall be considered unserviceable if there is a significant period of poor quality data, unintelligible signals, or if one or more of the mandatory parameters is not recorded correctly.
- 7.4 A report of the annual inspection shall be made available on request to regulatory authorities for monitoring purposes.
- 7.5 Calibration requirements of the FDR system shall be as follows:
- (a) For those parameters which have sensors dedicated only to the FDR and are not checked by other means, recalibration shall be carried out at least every five years or in accordance with the recommendations of the sensor manufacturer to determine any discrepancies in the engineering conversion routines for the mandatory parameters, and to ensure that parameters are being recorded within the calibration tolerances;.
  - (b) When the parameters of altitude and airspeed are provided by sensors that are dedicated to the FDR system, there shall be a recalibration performed as recommended by the sensor manufacturer, or at least every two years.

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## CHAPTER 4.12: FLIGHT RECORDERS APPENDIX 2

# FLIGHT RECORDERS FOR HELICOPTERS

EFFECTIVE DATE : 11 JANUARY 2017  
REVISION NO : 25 (ISSUE 2)

The material in this Appendix concerns flight recorders intended for installation in helicopters registered in Singapore. Crash protected flight recorders comprise four systems: a flight data recorder (FDR), a cockpit voice recorder (CVR), an airborne image recorder (AIR) and a data link recorder (DLR).

### **1 General requirements**

- 1.1 The flight recorder systems containers shall:
- (a) be painted a distinctive orange or yellow colour;
  - (b) carry reflective material to facilitate their location; and
  - (c) have securely attached an automatically activated underwater locating device.
- 1.2 The flight recorder systems shall be installed so that:
- (a) the probability of damage to the recordings is minimized;
  - (b) they receive electrical power from a bus that provides the maximum reliability for operation of the flight recorder systems without jeopardizing service to essential or emergency loads;
  - (c) there is an aural or visual means for pre-flight checking that the flight recorder systems are operating properly; and
  - (d) if the flight recorder systems have a bulk erasure device, the installation shall be designed to prevent operation of the device during flight time or crash impact.
- 1.3 The flight recorder systems, when tested by methods approved by the appropriate certificating authority, shall be demonstrated to be suitable for the environmental extremes over which they are designed to operate.
- 1.4 Means shall be provided for an accurate time correlation between the flight recorder systems functions.
- 1.5 The manufacturer usually provides the appropriate certificating authority with the following information in respect of the flight recorder systems:

- (a) manufacturer's operating instructions, equipment limitations and installation procedures; and
- (b) manufacturer's test reports.

## **2 Flight data recorder (FDR)**

### **2.1 Parameters to be recorded**

- (a) Flight data recorders for helicopters shall be classified as Type IV, IVA and V depending upon the number of parameters to be recorded.
- (b) The parameters that satisfy the requirements for Types IV, IVA and V FDRs, are listed in the paragraphs below. The number of parameters to be recorded shall depend on helicopter complexity. The parameters without an asterisk (\*) are mandatory parameters which shall be recorded regardless of helicopter complexity. In addition, the parameters designated by an asterisk (\*) shall be recorded if an information data source for the parameter is used by helicopter systems or the flight crew to operate the helicopter. However, other parameters may be substituted with due regard to the helicopter type and the characteristics of the recording equipment.
  - (1) The following parameters shall satisfy the requirements for flight path and speed:
    - Pressure altitude
    - Indicated airspeed
    - Outside air temperature
    - Heading
    - Normal acceleration
    - Lateral acceleration
    - Longitudinal acceleration (body axis)
    - Time or relative time count
    - Navigation data\*: drift angle, wind speed, wind direction, latitude/longitude
    - Radio altitude\*
  - (2) The following parameters shall satisfy the requirements for attitude:
    - Pitch attitude
    - Roll attitude
    - Yaw rate
  - (3) The following parameters shall satisfy the requirements for engine power:
    - Power on each engine: free power turbine speed (Nf), engine torque, engine gas generator speed (Ng), cockpit power control position
    - Rotor: main rotor speed, rotor brake
    - Main gearbox oil pressure\*
    - Gearbox oil temperature\*: main gearbox oil temperature, intermediate gearbox oil temperature, tail rotor gearbox oil temperature
    - Engine exhaust gas temperature (T4)\*
    - Turbine inlet temperature (TIT)\*

- (4) The following parameters shall satisfy the requirements for operation:
- Hydraulics low pressure
  - Warnings
  - Primary flight controls — pilot input and/or control output position: collective pitch, longitudinal cyclic pitch, lateral cyclic pitch, tail rotor pedal, controllable stabilator, hydraulic selection
  - Marker beacon passage
  - Each navigation receiver frequency selection
  - AFCS mode and engagement status\*
  - Stability augmentation system engagement\*
  - Indicated sling load force\*
  - Vertical deviation\*: ILS glide path, MLS elevation, GNSS approach path
  - Horizontal deviation\*: ILS localizer, MLS azimuth, GNSS approach path
  - DME 1 and 2 distances\*
  - Altitude rate\*
  - Ice detector liquid water content\*
  - Helicopter health and usage monitor system (HUMS)\*: engine data, chip detectors, channel timing, exceedance discretes, broadband average engine vibration

- (5) The following parameters shall satisfy the requirements for configuration:
- Landing gear or gear selector position\*
  - Fuel contents\*
  - Ice detector liquid water content\*

*Note: Parameter guidance for range, sampling, accuracy and resolution are as contained in the EUROCAE ED-112, Minimum Operational Performance Specifications (MOPS) for Crash Protected Airborne Recorder Systems, or equivalent documents.*

- (6) Type IVA FDR. This FDR will be capable of recording, as appropriate to the helicopter, at least the 48 parameters in Table 2.
- (7) Type IV FDR. This FDR shall be capable of recording, as appropriate to the helicopter, at least the first 30 parameters in Table 2.
- (8) Type V FDR. This FDR shall be capable of recording, as appropriate to the helicopter, at least the first 15 parameters in Table 2.
- (9) If further recording capacity is available, recording of the following additional information shall be considered:
- (i) additional operational information from electronic displays, such as electronic flight instrument systems (EFIS), electronic centralized aircraft monitor (ECAM) and engine indication and crew alerting system (EICAS); and

- (ii) additional engine parameters (EPR,  $N_1$ , fuel flow, etc.).

## 2.2 Additional information

- (a) The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.
- (b) Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/maintenance information shall be maintained by the operator/owner. The documentation shall be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

## 3 Cockpit voice recorder (CVR)

### 3.1 Signals to be recorded

- (a) The CVR shall record on four separate channels, or more, at least the following:
  - (1) voice communication transmitted from or received in the aircraft by radio;
  - (2) aural environment on the flight deck;
  - (3) voice communication of flight crew members on the flight deck using the interphone system, if installed;
  - (4) voice or audio signals identifying navigation or approach aids introduced in the headset or speaker; and
  - (5) voice communication of flight crew members using the passenger address system, if installed.
- (b) The CVR shall be capable of recording on at least four channels simultaneously. On tape-based CVR, to ensure accurate time correlation between channels, the CVR shall record in an in-line format. If a bi-directional configuration is used, the in-line format and channel allocation shall be retained in both directions.
- (c) The preferred channel allocation shall be as follows:
  - Channel 1 - co-pilot headphones and live boom microphone
  - Channel 2 - pilot headphones and live boom microphone
  - Channel 3 - area microphone
  - Channel 4 - time reference, main rotor speed or the flight deck vibration environment, the third and fourth crew member's headphone and live microphone, if applicable.

*Note 1: Channel 1 is located closest to the base of the recording head.*

*Note 2: The preferred channel allocation presumes use of current conventional magnetic tape transport mechanisms and is specified because the outer edges of the tape have a higher risk of damage than the middle. It is not intended to preclude use of alternative recording media where such constraints may not apply.*

#### **4. Airborne image recorder (AIR) and airborne image recording system (AIRS)**

##### **4.1 Classes**

- (a) A Class A AIR or AIRS captures the general cockpit area in order to provide data supplemental to conventional flight recorders.

*Note 1: To respect crew privacy, the cockpit area view may be designed as far as practical to exclude the head and shoulders of crew members whilst seated in their normal operating position.*

*Note 2: There are no provisions for Class A AIRs or AIRS in this document.*

- (b) A Class B AIR or AIRS captures data link message displays.

- (c) A Class C AIR or AIRS captures instruments and control panels.

*Note: A Class C AIR or AIRS may be considered as a means for recording flight data where it is not practical or prohibitively expensive to record on an FDR, or where an FDR is not required.*

#### **5 Data link recorder (DLR)**

##### **5.1 Applications to be recorded**

- (a) Where the helicopter flight path is authorized or controlled through the use of data link messages, all data link messages, both uplinks (to the helicopter) and downlinks (from the helicopter), shall be recorded on the helicopter. As far as practicable, the time the messages were displayed to the flight crew and the time of the responses shall to be recorded.

*Note: Sufficient information to derive the content of the data link communications message and the time the messages were displayed to the flight crew is needed to determine an accurate sequence of events on board the aircraft.*

- (b) Messages applying to the applications listed below shall be recorded. Applications without the asterisk (\*) are mandatory applications which shall be recorded regardless of the system complexity. Applications with an (\*) are to be recorded only as far as is practicable given the architecture of the system.

- Data link initiation capability
- Controller – pilot data link communications

- Data link – flight information services
- Automatic dependent surveillance – contract
- Automatic dependent surveillance – broadcast\*
- Aeronautical operational control\*

*Note : Descriptions of the applications are contained in Table 3.*

## **6 Aircraft data recording systems (ADRS)**

### **6.1 Parameters to be recorded**

ADRS shall be capable of recording, as appropriate to the helicopter, at least the essential (E) parameters in Table 5.

### **6.2 Additional information**

- (a) The measurement range, recording interval and accuracy of parameters on installed equipment is usually verified by methods approved by the appropriate certificating authority.
- (b) Documentation concerning parameter allocation, conversion equations, periodic calibration and other serviceability/ maintenance information shall be maintained by the operator. The documentation needs to be sufficient to ensure that accident investigation authorities have the necessary information to read out the data in engineering units.

## **7 Inspections of flight recorder systems**

7.1 Prior to the first flight of the day the built-in test features for the flight recorders and flight data acquisition unit (FDAU), when installed, shall be monitored by manual and/or automatic checks.

7.2 Annual inspections shall be carried out as follows:

- (a) an analysis of the recorded data from the flight recorders shall ensure that the recorder operates correctly for the nominal duration of the recording;
- (b) the analysis of the FDR shall evaluate the quality of the recorded data to determine if the bit error rate (including those introduced by recorder, the acquisition unit, the source of the data on the helicopter and by the tools used to extract the data from the recorder) is within acceptable limits and to determine the nature and distribution of the errors;
- (c) a complete flight from the FDR shall be examined in engineering units to evaluate the validity of all recorded parameters. Particular attention shall be given to parameters from sensors dedicated to the FDR. Parameters taken from the aircraft's electrical bus system need not be checked if their serviceability can be detected by other aircraft systems;
- (d) the readout facility shall have the necessary software to accurately convert the recorded values to engineering units and to determine the status of discrete signals;

- (e) an annual examination of the recorded signal on the CVR shall be carried out by replay of the CVR recording. While installed in the aircraft, the CVR shall record test signals from each aircraft source and from relevant external sources to ensure that all required signals meet intelligibility standards;
  - (f) where practicable, during the annual examination, a sample of in-flight recordings of the CVR shall be examined for evidence that the intelligibility of the signal is acceptable.; and
  - (g) an annual examination of the recorded images on the AIR shall be carried out by replay of the AIR recording. While installed in the aircraft, the AIR shall record test images from each aircraft source and from relevant external sources to ensure that all required images meet recording quality standards.
- 7.3 Flight recorder systems shall be considered unserviceable if there is a significant period of poor quality data, unintelligible signals, or if one or more of the mandatory parameters is not recorded correctly.
- 7.4 A report of the annual inspection shall be made available on request to regulatory authorities for monitoring purposes.
- 7.5 Calibration requirements of the FDR system shall be as follows:
- (a) For those parameters which have sensors dedicated only to the FDR and are not checked by other means, recalibration shall be carried out at least every five years or in accordance with the recommendations of the sensor manufacturer to determine any discrepancies in the engineering conversion routines for the mandatory parameters and to ensure that parameters are being recorded within the calibration tolerances.
  - (b) When the parameters of altitude and airspeed are provided by sensors that are dedicated to the FDR system, there shall be a recalibration performed as recommended by the sensor manufacturer, or at least every two years.

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**SECTION 5**  
*AIRCRAFT PERFORMANCE*

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## CHAPTER 5.1

# WEIGHT CONTROL OF AIRCRAFT

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

Pursuant to paragraph 16 of the Air Navigation Order, this Chapter prescribes the requirements for weighing Singapore aircraft including helicopters, the determination of the centre of gravity of such aircraft and preparation of Basic Weight Schedules and Weight and Balance Reports.

### 2 Definitions

#### 2.1 Basic Weight

Basic Weight is the weight of the aircraft and all its basic equipment and that of the declared quantity of unusable fuel and unusable oil. In the case of turbine engined aircraft and aircraft of 5700 kg maximum total weight authorised (MTWA) or less it may also include the weight of usable oil.

#### 2.2 Basic Equipment

Basic Equipment is the unconsumable fluids, and equipment which is common to all roles in which the operator intends to use the aircraft.

#### 2.3 Variable Load

Variable Load is the weight of the crew and of items such as the crew's baggage, removal units and other equipment the carriage of which depends upon the role for which the operator intends to use the aircraft for the particular flight.

#### 2.4 Aircraft Prepared for Service, or Operating Weight

The sum of the Basic Weight and the total Variable Load required for the particular role in which the operator intends to use the aircraft.

#### 2.5 Disposable Load

Disposable Load is the weight of all persons and items of load, including fuel and other consumable fluids, carried in the aircraft other than the Basic Equipment and Variable Load.

Note: To obtain the total loaded weight it is necessary to add to the Basic Weight the weights of the Variable and Disposable Load items to be carried for the particular role in which the aircraft is to be used.

**3 Weighing Requirements**

- 3.1 All aircraft shall be weighed in Singapore prior to the initial issue of a Singapore Certificate of Airworthiness. Exemption for weighing may be granted for aircraft which were weighed overseas prior to their importation and for which any subsequent changes in weight have been computed and recorded, provided all the necessary weight and balance data for the aircraft are furnished to the DGCA and such data are found to be accurate and adequate.
- 3.2 Aircraft shall be re-weighed within two years after the date of manufacture and thereafter at intervals not exceeding five years, and at such other times as the DGCA may require. Aircraft weighing shall be conducted in accordance with procedures acceptable to the DGCA. Essential aspects of the conduct of weighing are given in Appendix 3.
- 3.3 When an aircraft is weighed, the condition of the aircraft (i.e. the equipment, the position of movable items and other items of load such as fluids in tanks) shall be recorded. The equipment installed at the time of weighing should not differ from that in the declared Basic Equipment list associated with the Basic Weight Schedule (see paragraph 4). Otherwise, in determining the Basic Weight and the corresponding centre of gravity position, corrections will have to be made for items that have been weighed but that are not Basic Equipment items, and for Basic Equipment items not installed in the aircraft during the weighing.
- 3.4 Weighing results and related calculations shall be recorded in a weighing report which shall be retained by the operator. When the aircraft is again weighed the previous weighing records must be retained with the aircraft records.
- 3.5 The operator shall maintain records of all known weight and centre of gravity changes which occur after the aircraft has been weighed and such records shall be retained by the operator.

**4 Basic Weight Schedule**

- 4.1 A Basic Weight Schedule shall be provided for each aircraft. Each Schedule shall be identified by the aircraft type and model number, the nationality and registration marks and the aircraft serial number. The date of issue and the reference number of the Schedule shall be given and the Schedule shall be signed by a person suitably qualified and acceptable to the DGCA. A statement shall be included stating that the Schedule supersedes all earlier issues.
- 4.2 The Schedule shall present the derivation of the Basic Weight and the centre of gravity from the most recent weighing report or Basic Weight Schedule or other acceptable information. The Schedule shall indicate the landing gear positions (retracted or extended) to which the derived centre of gravity position is related. The Schedule shall also include the current Basic Equipment list showing the weight and lever arm of each item or make reference to the document in which such a list is included.
- 4.3 The date and reference number of the most recent weighing report, Basic Weight Schedule or other acceptable information, upon which the Schedule is based, shall be given.

- 4.4 The Basic Weight Schedule may be in the form given in Appendix 2 to this Chapter. Variations in presentation are permitted, but must be acceptable to the DGCA. In the case of helicopters, it may be necessary to present lever arms and moments about more than one axis, depending on the centre of gravity limits specified in the Flight Manual.
- 4.5 The datum which is defined in the Basic Weight Schedule may be different from the datum defined in the Certificate of Airworthiness or Flight Manual to which the centre of gravity limits relate. When a different datum is used it shall be adequately defined, its precise relationship to the datum in the Certificate of Airworthiness or Flight Manual shall be given, and any lever arms and moments which appear in any part of the Schedule shall be consistent with the datum so declared.
- 4.6 The Schedule shall be retained by the operator and where the Schedule has been revised the previous issue must be retained with the aircraft records.
- 4.7 Operators shall revise the Basic Weight Schedule when the weight and centre of gravity are known to have undergone changes in excess of a maximum figure, which has been agreed by the DGCA as applicable to a particular aircraft type.

Note: The following changes in basic weight or centre of gravity position are considered significant and must be reported to the DGCA:

- (a) Aeroplanes whose empty weight has changed by more than 0.5% of the maximum total weight authorised or whose basic centre of gravity position has changed by more than 0.5 % of the mean aerodynamic chord.
- (b) Helicopters whose empty weight has changed by more than 1% of the maximum total weight authorised or whose basic centre of gravity position has changed by more than 0.5 inch or 10% of the maximum permissible centre of gravity range whichever is the lesser.

## **5 Weight and Balance Report**

- 5.1 A Weight and Balance Report shall be produced for each Singapore aircraft. A copy of each report shall be supplied to the DGCA.
- 5.2 The Weight and Balance Report is intended to record the essential loading data to enable the particular aircraft to be correctly loaded and to include sufficient information for an operator to produce written loading instructions in accordance with the requirements of the Singapore Air Navigation Order.
- 5.3 The Weight and Balance Report shall include the following items:
- (a) Reference number and date of issue.
- (b) Type and model number of the aircraft and its nationality and registration mark.

(c) Basic Weight

The Basic Weight and centre of gravity of the aircraft as derived from the Basic Weight Schedule shall be presented. A copy of the Basic Weight Schedule, including the Basic Equipment list, and any referenced weighing report, shall be attached to the Report.

(d) Datum definition

A diagram or a description of the datums (e.g. in relation to the fuselage frame numbering system or other identifiable points) shall be included. See also paragraph 4.5.

(e) Variable Load

Information on the weight and lever arms appropriate to Variable Load items may be detailed for as many roles as the operator wishes and for every role the total weight and moment change shall be given. Weights of crew members may be assumed at not less than the weight shown in the Singapore Air Navigation Order, provided the aircraft has a total seating capacity of 12 or more persons. Otherwise the weight of each person must be found by weighing.

(f) Loading Information

This shall include all relevant information so that, knowing the disposable load which is intended to be carried, the weight and the position of the centre of gravity of the aircraft can be calculated. At least the following shall be given:

- (1) The lever arm of the centre of gravity of an occupant of each seat.
- (2) The lever arm of each compartment or area in the aircraft where disposable load, such as luggage or freight, may be placed.
- (3) Any significant change in the centre of gravity of the aircraft (change in moment) which will result from a change in configuration, such as the retraction and extension of the landing gear.
- (4) The lever arm of the centre of gravity of fuel and oil in each tank including the variation of the lever arm with the quantity loaded if this variation is significant.
- (5) The maximum total usable capacities of the fuel and oil tanks and the weight of fuel and oil when the tanks are filled to their capacities assuming typical densities of these fluids.

(g) A statement shall be given in the Schedule to the effect that pursuant to the Singapore Air Navigation Order the pilot-in-command shall satisfy

himself before take-off that the load is of such weight, and is so distributed and secured that it may safely be carried on the intended flight.

- (h) A statement that the Report supersedes all earlier issues.
- 5.4 The weights, distances, moments and quantities may be given in any units provided that these are used consistently and agree with the markings and placards on the aircraft.
- 5.5 A copy of the Report shall be included in the Flight Manual of all aircraft not exceeding 5 700 kg MTWA. If a Flight Manual is not applicable, the Report shall be displayed or retained in the aircraft in a suitably identified stowage.
- 5.6 Operators shall revise the Weight and Balance Report when there is a change to any of the items in paragraph 5.3.
- 5.7 The Weight and Balance Report may be in the form given in Appendix 1 to this Chapter. Variations in presentation are permitted, but must be acceptable to the DGCA. |

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## CHAPTER 5.1 : WEIGHT CONTROL OF AIRCRAFT

### APPENDIX 1

# EXAMPLE OF A WEIGHT AND BALANCE REPORT

EFFECTIVE DATE : 15 JULY 2000

REVISION NO : 0 (ISSUE 2)

### SPECIMEN WEIGHT AND BALANCE REPORT

Reference Number	- NAL/WBR/123
Date of Issue	- 1 January 1989
Produced by	- New Aviation Ltd
Aircraft Type and Model	- Flynow 2E
Nationality and Registration Marks	- 9V-ABC
Constructor	- F.L.Y. Co Ltd.
Constructor's Serial Number	- 44
Maximum Total Weight Authorised	- 3320 kg
Centre-of-Gravity Limits	- Refer to Flight Manual reference Number FM/946

### PART A - BASIC WEIGHT

The basic weight of the aircraft as derived in the Basic Weight Schedule NAL/BWS/246 dated 31 December 1988 is - 2500 kg

The centre of gravity of the aircraft in the same condition at this weight and with the landing gear extended is - 127 in. aft of datum

The total moment about the datum in this condition in kg-in/100 is - 3175

Note:

- (1) The datum is at fuselage station 0 situated 114 inches forward of the wing leading edge. This is the datum defined in the Flight Manual. All lever arms are distances in inches aft of datum.
- (2) The basic weight includes the weight of 11 kg unusable fuel and 2.2 kg unusable oil.

**PART B - VARIABLE LOAD**

The weight, lever arm and moment of items of Variable Load are shown below. The Variable Load depends upon the equipment carried for the particular role.

<b>Item</b>	<b>Weight (kg)</b>	<b>Lever Arm inches</b>	<b>Moment kg/inches 100</b>
Pilot (one)	-	108	-
De-icing fluid 1½ gallon	5.5	140	8
Life-jackets (7)	6.4	135	9
Row 1 passenger seats (two)	27.2	173	47
Row 2 passenger seats (two)	27.2	215	58
Row 3 passenger seats (two)	27.2	248	68
Table	3.6	256	9
One stretcher and attachments (in place of seats rows 2 and 3)	20.5	223	46
Medical Stores	6.8	250	17

**PART C - LOADING INFORMATION (DISPOSABLE LOAD)**

The total moment change when the landing gear is retracted is 8.2 kg-in/100. The appropriate lever arms are:

<b>Item</b>	<b>Weight (kg)</b>	<b>Lever Arm inches</b>	<b>Capacity Imp.Gallon</b>
Fuel in tanks 1 and 2	620*	145	190
Engine oil	23*	70	5.6
Forward baggage		21	
Rear baggage		261	
Passengers in row 1 seats		171	
Passengers in row 2 seats		213	
Passengers in row 3 seats		246	
Patient in stretcher		223	

Fuel density 3.26 kg/gal and oil density 4.1 kg/gal.

In accordance with the Air Navigation Order, it is a requirement that the pilot satisfies himself before take-off that the load is of such a weight, and is so distributed and secured, that it may safely be carried on the intended flight.

Note: To obtain the total loaded weight of aircraft, add to the Basic Weight the weights of the Variable and Disposable Load items to be carried for the particular role.

This Report was prepared on \_\_\_\_\_ (date) \_\_\_\_\_ and supersedes all previous issues.

Name and Designation \_\_\_\_\_

Signed: \_\_\_\_\_

—

On behalf of: \_\_\_\_\_

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## CHAPTER 5.1 : WEIGHT CONTROL OF AIRCRAFT APPENDIX 2

### EXAMPLE OF A BASIC WEIGHT SCHEDULE

EFFECTIVE DATE : 15 JULY 2000  
REVISION NO : 0 (ISSUE 2)

#### SPECIMEN BASIC WEIGHT SCHEDULE

Reference Number - NAL/BWS/246

Date of Issue - 31 December 1988

Aircraft Type and Model - Flynow 2E

Nationality and Registration Marks - 9V-ABC

Aircraft Serial Number - 44

#### COMPUTATION OF BASIC WEIGHT AND CENTRE-OF-GRAVITY POSITION

Description	Weight	Arm	Moment (kg-in)
Aircraft weight as per weighing report WR/789 dated 30 December 1988	2475	126	311850
Total of items weighed but not part of Basic Equipment (listed to be given)	-25	-	-650
Total of Basic Equipment items not weighed (list to be given)	+50	-	+5000
Basic Weight	2500	127	317500

Or

<b>Description</b>	<b>Weight</b>	<b>Arm (in)</b>	<b>Moment (kg-in)</b>
Aircraft basic weight as per Basic Weight Schedule NAL/BWS/245 dated 20 June 1988	2475	126	311850
Total of Basic Equipment items removed (list to be given)	-25	-	-650
Total of Basic Equipment items added (list to be given)	+50	-	+5000
New Basic Weight	2500	127	317500

**Note:** The datum is at fuselage station O situated 114 inches forward of the wing leading edge. This is the datum defined in the Flight Manual. All lever arms are distances in inches aft of datum.

Current Basic Equipment List (may be given on separate sheets and attached to Schedule)

<b>Item</b>	<b>Weight</b>	<b>Arm (in)</b>
Two Marzell propeller type BL – H3Z30	57.6 each	76
Two engine driven 100 ampere alternative type GE-361	12.2 each	117
One 13 AH Ni-Cd battery CB-7	14	153
Etc	etc	etc

This Schedule was prepared on \_\_\_\_\_ (date) and supersedes all previous issues.

Name and Designation: \_\_\_\_\_

Signed: \_\_\_\_\_

On behalf of: \_\_\_\_\_

## CHAPTER 5.1 : WEIGHT CONTROL OF AIRCRAFT APPENDIX 3

### CONDUCT OF WEIGHING

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

- 1 The following aspects should be adhered to and included in company weighing procedures:
  - (a) All weighings shall be supervised by a suitably qualified person who is acceptable to the DGCA.
  - (b) Weighing equipment should be suitable for the purpose. Evidence should be available, if necessary, to show that the equipment is regularly inspected and calibrated and its errors are within the tolerances specified by the equipment manufacturer or local weights and measure authority requirements.
  - (c) The staff are trained and handling equipment is adequate to permit weighings to be made accurately and safely.
  - (d) Unless otherwise agreed to by the DGCA a weighing shall consist of two independent weighings made with the aircraft longitudinal datum horizontal. The load must be removed from the weighing equipment between the weighings. Any discrepancy in the weighings shall not exceed 0.2 per cent of the gross weight or 25 lbs whichever is greater. If this tolerance is exceeded further weighings should be performed until the results between two consecutive weighings agree within the tolerance.
  - (e) A weighing report should be produced to provide a record of all measurements and calculations pertinent to the weighing. The report should include a list of equipment installed on the aircraft at the time of weighing.

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## CHAPTER 5.2

# FLIGHT MANUALS

EFFECTIVE DATE : 15 DECEMBER 2011  
REVISION NO : 18 (ISSUE 2)

### 1 General

- 1.1 Pursuant to the Singapore Air Navigation Order, the flight manual is part of the Certificate of Airworthiness and Singapore aircraft are required to be operated in accordance with an approved Flight Manual or other acceptable data. This Chapter prescribes the requirements for such manuals.

### 2 Contents

- 2.1 Flight Manuals approved in accordance with the requirements of the State of Design of the aircraft are generally acceptable for approval.
- 2.2 Each Flight Manual shall contain the following information, including instructions where necessary, relating to:
- (a) Nationality and registration marks of the aircraft, together with its type and model number and the manufacturer's serial number.
  - (b) Except where other means of providing the information are approved, the operating procedures, operational limitations and loading of the aircraft.
  - (c) The performance data for the aircraft.
  - (d) The date of approval or the currentness of the document.

### 3 Amendment

- 3.1 Changes or amendments shall not be made to a Flight Manual without the approval of the DGCA.
- 3.2 The DGCA may direct the owner of operator of a Singapore aircraft to change or amend a Flight Manual, where necessary, to maintain the airworthiness or safety standard of an aircraft. Such action may result from either:

- (a) A proposed modification to the aircraft or its equipment.
  - (b) A proposal by the operator or owner which affects the operation of the aircraft.
  - (c) Other occurrences affecting the airworthiness or safety of the aircraft.
- 3.3 A copy of all proposed changes and amendments, including those approved by the State of Manufacture of the aircraft, shall be supplied for approval by the DGCA.
- 3.4 The Flight Manual shall be made available for examination by the DGCA before a Certificate of Airworthiness is renewed and on request at other times.

## CHAPTER 5.3

# TEST AND SPECIAL FLIGHTS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

1.1 The Singapore Air Navigation Order prescribes the requirements in respect of operation of an aircraft without a valid Certificate of Airworthiness. The conditions for approval and conduct of such flights are stated in the Schedules to the Air Navigation Order as 'A' Conditions, 'B' Conditions and 'C' Conditions.

1.2 This Chapter prescribes the requirements for:

- (a) The certification of aircraft and conduct of flights to be made as Condition 'A' flights; and
- (b) Airworthiness flight tests.

Note: Flights made in accordance with Conditions 'B' or 'C' will be approved separately.

### 2 Certification for Flight under 'A' Conditions

2.1 The aircraft shall be inspected by appropriately licensed aircraft maintenance engineers to determine whether it is fit for flight and a Certificate of Fitness for Flight as specified in paragraph 2.3 shall be issued on completion of the inspection.

2.2 The validity of the certificate shall not exceed seven days. It shall be issued in duplicate, the original shall be included with the technical log and the duplicate retained by the operator separately from the aircraft. The aircraft shall be re-inspected and the certificate re-issued if the airworthiness condition of the aircraft is affected during the period of validity.

2.3 The Certificate of Fitness for Flight shall include the following:

- (a) A certification to the effect that the aircraft has been inspected and is fit for flight provided it is loaded in accordance with the approved Weight and Balance Report.
- (b) The approved data or schedules, etc., used for the inspection.
- (c) A statement of the period of validity of the Certificate and that it ceases to be valid if the airworthiness condition of the aircraft is altered.
- (d) The name, licence number or approval designation of the person making the certification.

**3 Airworthiness Flight Tests**

3.1 Flight tests may be required in the following circumstances:

- (a) Prior to the issue of a Singapore Certificate of Airworthiness.
- (b) Periodically to determine whether the handling characteristics, functioning and performance of an aircraft continues to comply with the requirements that were acceptable to the DGCA when the aircraft was issued with a Singapore Certificate of Airworthiness.
- (c) On completion of a modification or other work likely to affect the handling characteristics, functioning or performance of an aircraft.

3.2 Flight test schedules shall be prepared in conjunction with the DGCA and must be acceptable to the DGCA.

3.3 Schedules for flight tests required by paragraphs 3.1(a) and (b) shall, except where otherwise agreed, include tests to check:

- (a) The performance of the aircraft.
- (b) The handling characteristics of the aircraft. These tests will be based on the results of the test during type certification and the subsequent history of the type.
- (c) The functioning of aircraft controls, major systems and components in flight.
- (d) Other aspects required by the DGCA.

3.4 Schedules for flight tests required by paragraph 3.1(c) shall:

- (a) in respect of modifications or other work outside the scope of manufacturer's documents, include tests to:
  - (i) determine whether the aircraft continues to comply with the airworthiness requirements observed for its type certification.
  - (ii) establish whether revision of the Flight Manual handling or performance data is necessary.
  - (iii) determine the data for such revisions.
- (b) in respect of modifications or other work made in accordance with manufacturer's documents, approved maintenance manuals or completed subsequently to the final approval of work as specified in paragraph 3.4(a):
  - (i) state the flight tests required.
  - (ii) specify the procedures and standards to be observed.

**4 Flight Test Reports**

- 4.1 A copy of flight test reports in an acceptable format shall be submitted to the DGCA on completion of all airworthiness flight tests except those made in accordance with paragraph 3.4(b). A copy of all flight test reports shall be retained by the operator with the aircraft records.

**5 Flight Test Personnel and Facilities**

- 5.1 The qualifications and experience of flying staff and other persons engaged in flight tests, together with the facilities and equipment provided for the tests shall be acceptable to the DGCA.

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**SECTION 6**

*APPROVAL OF PERSONS AND  
ORGANISATIONS*

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## CHAPTER 6.5

# APPROVAL OF WELDERS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

- 1.1 Pursuant to ANO paragraph 8 and paragraph 10. This Chapter is applicable to persons who weld parts which are essential to the airworthiness of an aircraft where the making of a sound joint by the welding process depends largely on the competency of the operator.
- 1.2 Welders will be approved in accordance with the requirements of this Chapter and Appendix 1.
- 1.3 This Chapter prescribes the procedures for approving welders, and also prescribe the responsibilities of the approved welders and of the Approved Organisations employing them.

### 2 Approval of Welders

- 2.1 An approved organisation may employ, train, qualify and grant approval to welders to perform work under its scope of approval, subject to the following:
  - (a) It has an established system of training, qualifying, testing, approving, re-approving and monitoring the welders in its employ.
  - (b) It has a system of maintaining the training records of welders, qualification, testing and issue of approval and re-approval.
  - (c) Such system shall be approved by the DGCA in the Approved organisation's exposition document.
- 2.2 Notwithstanding paragraph 2.1 (a), an Approved Organisation may be approved to utilise an external approved organisation for initial training, qualification and approval of welders. However, the re-approval of welder is the responsibility of the Approved Organisation and shall be in accordance with this Chapter.
- 2.3 Welder Approvals are granted with specific ratings of metal groups and welding processes and with restrictions prescribing the type of welding work that may be undertaken (e.g. sheet to sheet, tube to tube). The metal groups and welding processes are given in Appendix 1.
- 2.4 Welder Approvals are granted with a maximum validity period of twelve months. The approval granted to a welder in the employ of an Approved Organisation will be invalidated automatically if the welder leaves that Organisation.

- 2.5 An applicant for the issue or re-issue of a welder's approval shall:
- (a) Be employed by an Approved Organisation who shall ensure that the applicant is able to read, write and converse in the English language and not suffering from any disability likely to affect his technical skill or judgement.
  - (b) Provide evidence of his qualifications and practical experience in welding.
  - (c) Satisfactorily complete the appropriate test samples and meet the examination requirements specified in Appendix 1.
- 2.6 The holder of a welder's approval is approved to certify for completion of work provided:
- (a) the approval is valid and appropriate for the type of material and welding process used.
  - (b) the work consists solely of welding.
  - (c) that where necessary the welding process followed and the material used comply with approved data or design documents specified for the work.
  - (d) the certification is only made in respect of the quality of the welding and of the fact that an approved process has been followed.

Note: An approved welder is not permitted to certify the welded parts unless approved as a person competent to issue a Certificate of Release to Service.

### **3 Procedures for the Issue of Approval**

- 3.1 The Approved Organisation employing the welder shall make arrangements for the welder to prepare and weld test samples in accordance with the requirements specified in Appendix 1.
- 3.2 The Approved Organisation shall arrange to submit the test samples to an Approved Test Organisation for examination together with full particulars of the welder concerned, materials and welding processes used, test sample figure numbers and identification marks on the test samples.
- 3.3 When the welder has made an application and after the test results furnished by the Approved Test Organisation are found satisfactory, the Approved Organisation may then issue a welder's approval to the welder for the materials and welding processes used and prescribing any restrictions.

### **4 Procedures for the Renewal of Approval**

Note: Should approval be sought for a rating (material and welding process used) or restriction different from that already granted, the procedures for the issue of approval as detailed in paragraph 3 shall be followed.

- 4.1 The Approved Organisation employing the welder shall arrange for renewal examinations of the welder's competency for each of the approved rating/restriction combination.
- 4.2 To ensure continuity of a welder's approval the renewal examination should be carried out before the expiry date of the approval, but not more than two months before the expiry date. The examination should be scheduled so that the results can be known before the approval expires.
- 4.3 At each renewal examination, the Approved Organisation shall make arrangements for the welder to prepare and weld an appropriate test sample in accordance with the requirements specified in Appendix 1.
- 4.4 The Approved Organisation shall arrange to submit the test sample to an Approved Test Organisation for examination together with full particulars of the welder concerned, material and welding process used, test sample figure number and identification marks on the test sample.
- 4.5 When the welder has made an application and after the test results furnished by the Approved Test Organisation are found satisfactory, the Approved Organisation may then renew the welder's approval.
- 4.6 If the test results are unsatisfactory the Approved Organisation employing the welder shall arrange for the renewal examination to be repeated immediately and the test sample sent to an Approved Test Organisation for examination. After these unsatisfactory test results are known and before the results of the repeated renewal examination are known the welder shall not weld parts that are essential to the airworthiness of an aircraft. If the test results of the repeated renewal examination are satisfactory, the welder's approval may then be renewed.

Note: If, however, the test results of the repeated renewal examination are again unsatisfactory the welder's approval shall be suspended until further training and/or experience has been gained to the satisfaction of the Approved Organisation, and a further examination has been satisfactorily completed.

## **5 Test Reports from Approved Test Organisations**

- 5.1 The Approved Test Organisations examining the test samples shall send a copy of all test reports to the Approved Organisation. The test reports shall detailed the test results and indicate also the date of receipt of the test samples and the date when testing is completed.

## **6 Records**

- 6.1 An Approved Organisation employing approved welders shall maintain a register of the welders' approvals as well as the records required in paragraphs 6.2 and 6.3 and shall keep copies of all test reports.
- 6.2 In relation to each approval (rating/restriction combination) issued, records shall be kept to indicate:

- (a) the date of preparation of the test sample.
- (b) the name of the authorised person supervising the preparation.
- (c) the name of the Approved Test Organisation to which the test sample has been sent for examination.
- (d) the date the test sample has been sent to the Approved Test Organisation.
- (e) the date the test report was received.
- (f) the test report reference.

6.3 In relation to the renewal of approvals, records shall be kept for the information required in paragraph 6.2 and, in addition, to indicate:

- (a) the scheduled date for the next renewal examination.
- (b) the period of suspension of approval, if any.

Note: Records for all renewal examinations, whether satisfactory or unsatisfactory, shall be kept.

6.4 All records shall be made available to an authorised person on request.

## **7 Checks by the DGCA**

7.1 The DGCA may select samples of approved welders' work at any time for additional check examination purposes.

## CHAPTER 6.5 : APPROVAL OF WELDERS

### APPENDIX 1

## EXAMINATION REQUIREMENTS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 Metal Groups and Welding Processes

- 1.1 Welder's approvals are granted for the following metal groups and welding processes:

#### Metal Group

- 1 - Aluminium alloys
- 2 - Magnesium alloys
- 3 - Low carbon steels
- 4 - Corrosion and heat resisting steels
- 5 - Nickel alloys
- 6 - Copper alloys
- 7 - Titanium alloys

#### Welding Processes

- 1 - Gas (oxy-acetylene, etc)
- 2 - Braze welding (oxy-gas)
- 3 - Metal-arc (flux coated consumable electrode)
- 4 - TIG (tungsten-arc inert gas shielded)
- 5 - MIG (metal-arc inert gas shielded - consumable electrode)
- 6 - Plasma-arc

- 1.2 Other metal groups and welding processes may be considered by the DGCA. |

### 2 Types of Test Samples

- 2.1 The standard test samples are shown in the following figures:

Figure 1 - Sheet to sheet butt weld

Figure 2 - Sheet to tube weld

Figure 3 - Tube to tube weld

The dimensions given in the figures are in millimetres and may be regarded as approximate.

Note : (1) Approval will be limited to welding material from the specified metal group using the specified process. The selection of test samples to be welded by the applicant

- (2) will further determine any restrictions to an approval in respect of the type of work to be undertaken.  
On application to the CAAS other test samples may be used if they would be more relevant to the work normally undertaken.

2.2 The test samples shall be prepared by the applicant under the direct supervision of a supervisor. The supervisor will examine the dimensions, preparation and fitting of the test samples, and ensure that the required materials and process are used and that the test samples are completed in accordance with the requirements of paragraph 3.

Note: The supervisor shall be a person authorised, in accordance with Chapter 6.1, by the Approved Organisation to supervise welders' preparation of test specimens.

2.3 Additional test samples may be used if the applicant is not satisfied with the quality of the weld. The test samples shall be submitted complete and suitably identified to an Approved Test Organisation for examination.

### **3 Welding of Test Samples**

Note: Irrespective of the type of test samples, completed welds shall not be dressed, hammered or sand blasted. Light tapping with a hammer to remove scale deposits is acceptable. Flux shall be removed by standard procedures.

#### **3.1 Figure 1 Test Sample**

The edges of the sheet to be welded may be chamfered when 1.5mm or thicker sheet is used. Edge preparation is not necessary for aluminium alloys thinner than 2.5mm. The welding shall be performed with the test piece flat and by forehand welding from one side only using the correct filler rod, flux or shielding gas as applicable.

#### **3.2 Figure 2 Test Sample**

A 12mm diameter hole shall be drilled in the centre of each end plate prior to welding. The end plates may be positioned by tack welds. The first weld shall be completed by working around the test piece with the end plate flat on the bench and the tube vertical. The second weld shall be completed by working under and over the test piece with the tube horizontal and not moved during the welding process.

#### **3.3 Figure 3 Test Sample**

The tubes shall be prepared, assembled in a jig and tack welded. The assembly is then to be removed from the jig and mounted in a vertical position with the 150mm long tube vertical and 75mm long tube (at 45 degrees) at the top. The assembly shall not be moved from this position until all welds are completed. The welding of the lower tube shall be made by working around the test piece and the other welds by overhead welding and working around the test piece.

#### **4 Cutting Test Specimens**

- 4.1 Test specimens shall be cut from test samples by an Approved Test Organisation in accordance with the details given in the appropriate figures.

#### **5 Specimen Examination**

- 5.1 Assessment of a weld shall be based on consideration of the sample weld as a whole, including the results obtained by visual, microscopical, and where applicable, mechanical testing. If any doubt exists regarding the quality of the weld, or any defect revealed is thought to be of a local character, further sections should be examined and final assessment shall be based on all the specimens examined.

Note: Figure 1 test specimens shall be subjected to tensile and bend tests.  
Figure 3 test specimens shall be subjected to tensile test.

- 5.2 The micro test specimen shall be examined at suitable magnifications in the unetched and etched conditions. A list of suitable etching reagents is given in Table 1.
- 5.3 The presence of intergranular oxide films is considered to be detrimental to the weld due to their embrittling effect, but the extent of these films is very difficult to determine in etched specimens. If the area of intergranular oxide is only very slight and satisfactory results are obtained by mechanical testing, further sections of the weld shall be examined before a decision is reached.
- 5.4 Where fillet welds are concerned, unless complete fusion is required by the drawing, a certain degree of lack of fusion is permissible at the roots:-
- (a) For fillet welds of 45° or more, the maximum lack of fusion which can normally be accepted is that revealed by a line of oxide extending from the root of the weld for a distance not greater than one-third of that between the root and the toes of the weld. Provided the amount of weld material used has been adequate, this method of assessment should ensure that the effective throat thickness of the weld is not less than the thickness of the sheets or tubes used for the specimens.
  - (b) For fillet welds at acute angles such as 30°, complete penetration in the root of tubular sections is difficult to achieve and there is a danger of collapse of the tube walls if excessive penetration is attempted. The presence of a fairly large cavity, or corresponding lack of fusion, is permissible at the root of such welds but there should be a bridge of weld metal and reasonable throat depth, showing satisfactory fusion to the basic metal.

5.5 Sheet to Sheet Butt Welds

The section must be free from excess oxidation, burning cracks, cavitation, porosity, scale and slag. The specimen must show adequate penetration when the underside of the weld is examined. If excessive penetration occurs along the entire length of the weld the specimen must be rejected, but isolated excrescence on the underside are permissible, provided the weld itself is free from cavities, oxide films, and other defects.

5.6 Tube to Sheet and Tube to Tube Welds

The specimen must show adequate penetration and freedom from excess oxidation, cracks, cavitation, porosity, scale and slag.

**6 Mechanical Testing of Specimens**

6.1 Tensile Test

6.1.1 Tensile test specimens shall be tested to destruction in direct tension. The ultimate stress (calculated on the minimum area of cross section of the specimen, i.e. ignoring the increase in thickness due to welding) and the location of the break shall be recorded. Tube to tube weld specimens shall be broken in a tensile test machine fitted with suitable shackles and pins, the pins being passed through the top and bottom cross tubes of the specimens, so that the tensile load may be applied without bending the specimens.

6.1.2 A weld will be considered satisfactory when the failure occurs in the parent metal. A test piece failing at the toe of the weld or in the weld material can only be considered satisfactory if the ultimate stress is found to exceed the minimum tensile strength of the parent metal as given in the appropriate material specification, and if the fracture surfaces are free from defects such as cracking, blow holes, excessive porosity or inclusions. No evidence of lack of adhesion such as the peeling away of the filler metal shall be apparent.

6.2 Bend Test

6.2.1 Bend test specimen shall be tested in bending so that the weld lies along the centre line of the bend and the weld face (the side from which the welding was performed) is on the outside of the bend.

6.2.2 To ensure the close contact of the specimen to the bar about which it is bent, the side of the specimen away from the weld face should be dressed down by filing or grinding until the weld is level with the parent metal. The edges of the specimen in the vicinity of the weld should be given reasonable radii.

6.2.3 Austenitic steel specimens must be given the "weld decay" pickling test prescribed in the relevant specification or in accordance with British Standard 5903 prior to the bend test.

6.2.4 The angle and radius of bend shall be as specified in the following table:

Material	Angle of Bend (degrees)	Radius of Bend (T=nominal thickness)
(a) Austenitic steels	90	3T
(b) Magnesium alloys	180	10T
(c) Aluminium alloys	180	5T
(d) Steels containing boron	180	3T
(e) Titanium alloys	180	5T
(f) Others	180	2T

Note: (1) In the event the bend test details exceed distortion limits of the parent material, the bend limitations of the parent material shall be used.

(2) Special test requirements may be specified by the DGCA. |

6.2.5 A bend test will be considered satisfactory if the test specimen withstands the bending without developing cracks visible to the unaided eye.

Note: If interpretation of the bend test results is in doubt, comparison may be made with the bend test performance of a separate sample of the parent material from which the test specimens were prepared.

TABLE 1 - ETCHING REAGENTS

Material	Reagent
Carbon steels	Saturated solution of picric acid in ethyl alcohol (industrial spirit grade)
	Concentrated nitric acid 2%) Ethyl alcohol (industrial spirit grade) 98%) (V/V)
Corrosion-resisting steels and nickel base alloys	Ferric Chloride 5g Concentrated hydrochloric acid 50ml Distilled water 100ml
	Concentrated nitric acid (used electrolytically)
	Oxalic acid ) used 10g Distilled water ) electrolytically 90ml
	Phosphoric acid ) used electrolytically 85%) Glycerine ) at 85° 15%) (V/V)
Aluminium alloys	Concentrated nitric acid 20%) Hydrofluoric acid (40%) 2%) (V/V) Distilled water 78%)
	Hydrofluoric acid (40%) 0.5%) Distilled water 99.5%) (V/V)
Magnesium	Concentrated nitric acid 1%) Distilled water 99%) (V/V)
Copper base alloys	Ferric Chloride 5g Concentrated hydrochloric acid 50ml Distilled water 100ml
Titanium alloys	Nitric acid 19%) Hydrofluoric acid 1%) (V/V) Distilled water 80%)

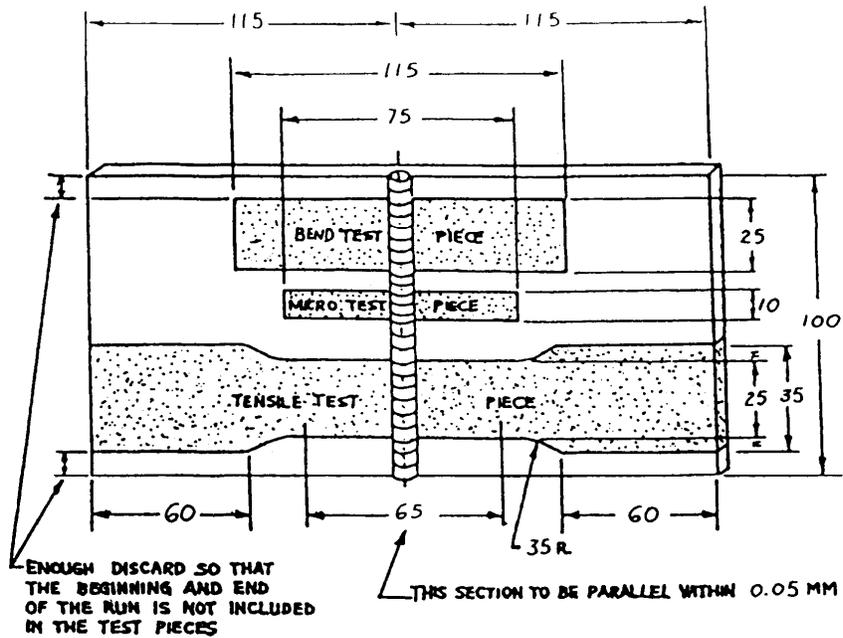


Figure 1 SHEET TO SHEET BUTT WELD

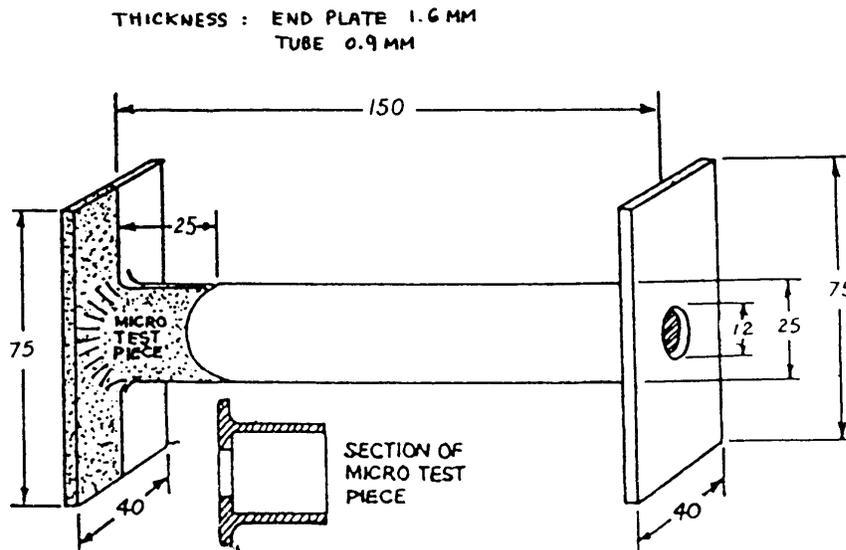


Figure 2 SHEET TO TUBE WELD

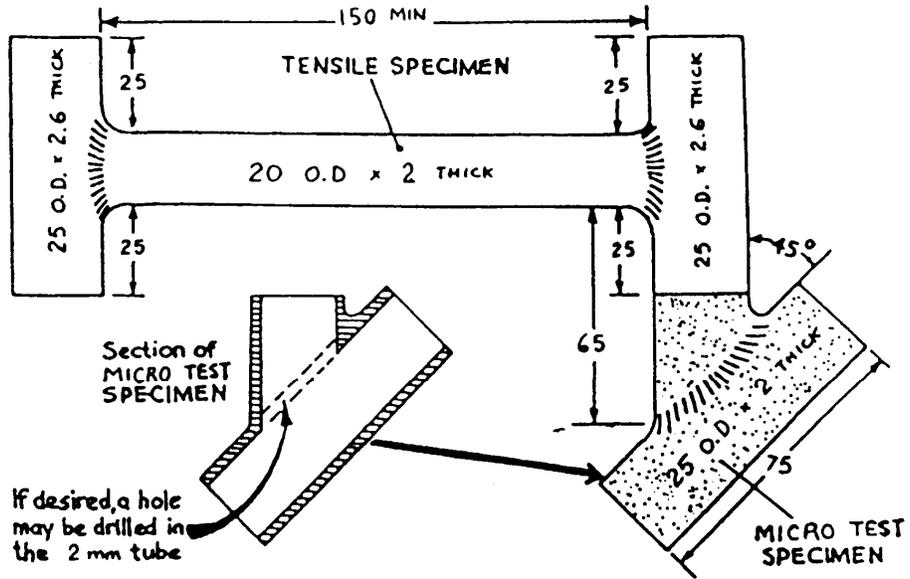


Figure 3 TUBE TO TUBE WELD

## CHAPTER 6.6

# APPROVAL AND RESPONSIBILITIES OF NON-DESTRUCTIVE TESTING OPERATORS

EFFECTIVE DATE : 15 DECEMBER 2011

REVISION NO : 18 (ISSUE 2)

### 1 General

1.1 This Chapter prescribes:

- (a) The requirements for the grant of an approval to undertake non-destructive testing of aircraft, components or equipment.
- (b) The responsibilities of approved non-destructive testing operators in respect of inspections on parts of an aircraft or its components and equipment, the failure of which could jeopardise the safety of an aircraft.

2 Approvals may be granted to undertake and certify non-destructive inspections by the following methods:

- (a) Liquid penetrant inspection involving the use of dip tanks, emulsifiers, and fluorescent dye penetrants.
- (b) Magnetic particle inspection.
- (c) Radiographic inspection.
- (d) Ultrasonic inspection.
- (e) Eddy current inspection.

3 An applicant for the grant or extension of a non-destructive testing approval shall:-

- (a) be able to read, write and converse in English language.
- (b) comply with the visual acuity requirements, and not be suffering from any disability likely to affect his technical skill or judgement. Visual acuity shall be such that his natural or corrected near vision is adequate to carry out the various functions. An annual test is required to ensure that he has a reasonable standard of visual acuity and does not suffer from any colour perception deficiency.

Note: A reasonable minimum standard of visual acuity would be the capability to read the J-1 letters of the standard Jaegers test type hart or Times Roman N4 at not less than 16" (42cm) or an

equivalent type test for near vision in at least one eye, natural or corrected. The test for colour perception is not required of applicants for radiographic and eddy current approvals.

- (c) have acceptable experience of at least one year dealing with the practical inspection of aircraft structures and components, or acceptable alternative training or experience. Specific practical experience and training shall be obtained where prescribed for a particular NDT method. In the case where the applicant has had experience on limited types of components, the applicant shall be limited to that scope of work. Where the applicant scope of work is extended to aircraft structures, and practical aircraft experience is insufficient, the examination will include a supplementary paper on aircraft structures. Guidance on the amount of practical experience is found in paragraph 6 of this chapter.
- (d) pass a written and/or oral examination to a standard approved by the DGCA on the appropriate syllabus.
- (e) demonstrate that he has adequate practical proficiency in the relevant NDT test method.

4 In lieu of paras 3(d) and 3(e) above the DGCA may accept the following:

- (a) The UK National Scheme in NDT (PCN Aerospace sector examinations or equivalent).
- (b) The Australian Institute for NDT scheme for aerospace qualifications.
- (c) The American Society for NDT recommended practice SNT-TC-1A, and National Aerospace Standards NAS 410.
- (d) International Standard ISO 9712.
- (e) European Standard EN473 /EN4179 qualifications.
- (f) Completion of training schemes approved by the DGCA.

5 Application for CAAS's NDT examinations shall be made on CAAS Form(AW)31 and submitted to the Safety Policy and Licensing Division, Civil Aviation Authority of Singapore, Singapore Changi Airport, Singapore 918141. Specific details of the applicant's qualifications and practical experience shall be submitted with the application.

6 NDT Approvals normally will only be granted to qualified persons in appropriately approved organisations. The issue of NDT approvals will be made by a nominated Senior Officer of the organisation to an applicant, following consent from the DGCA. Such approvals will continue to be in force provided the visual acuity of the holder is tested annually and meets the requirements of paragraph 3(b).

Note: From time to time, the holder may be required to submitted evidence to the DGCA that sufficient usage of the NDT method is being obtained to retain familiarity and proficiency.

- 7 The specific experience training requirements for approved radiographic and ultrasonic operators are as follows:
- (a) Practical experience shall include at least one year's work, using the particular method in the examination of aircraft structures, parts and components. For a radiographic inspection approval, the experience must also include processing and interpretation of radiographic.
  - (b) The application should have successfully completed a formal practical training course on the particular inspection method and passed the relevant examinations.
- 8 The practical examination to qualify for an approval will require a demonstration of using the particular NDT method. For a radiographic inspection approval, the examination will include a practical test and an interpretation test consisting of the following:-
- (a) (i) The development and recording of techniques for the examination of an aircraft part.
    - (ii) The practical application of the techniques.
    - (iii) The processing of radiographic films.
  - (b) (i) The co-relation of radiographs with a report.
    - (ii) Identification of various features of radiographs.
  - (c) Safety aspects and methods of preventing radiation hazards.

Note: Safety Precautions

In view of the serious consequences of excessive exposure of the human body X-radiation, it is recommended that the following precautions should be observed by operators:-

- (a) Film badge monitoring and total radiation absorbed dose records to be kept.
- (b) An annual blood count.
- (c) Personnel dosimeter.
- (d) A radiation intensity meter.

- 9 Pursuant to the Singapore Air Navigation Order, an approved Non-Destructive Testing operator is approved to certify for the completion of NDT inspections on a Certificate of Release to Service or on an Approved Certificate, as appropriate, provided:
- (a) The inspection is made by or under the direct supervision of the approved operator.
  - (b) The approval is valid and appropriate for the method of inspection.
  - (c) Where relevant the inspection is made in accordance with approved data and design documents.
  - (d) The certification is made solely in respect of the results of the inspection.

## CHAPTER 6.6 : APPROVAL AND RESPONSIBILITIES OF NON-DESTRUCTIVE TESTING OPERATORS

### APPENDIX 1

## SYLLABI OF NDT EXAMINATIONS

EFFECTIVE DATE : 15 JULY 2000

REVISION NO : 0 (ISSUE 2)

### 1 Dye Penetrant Inspection Syllabus

- 1.1 Principles of penetrant inspection.
- 1.2 Applicability; Types and characteristics of flaws, detectability of flaws, limitations on applicability to types of materials and types of flaws.
- 1.3 Penetrant Systems; Characteristics and basis of selection of types of penetrants, emulsifiers and developers; compatibility of penetrants.
- 1.4 Techniques of inspection; Advantages and limitations of the various methods of preparation; selection of methods of application of penetrant, emulsifier and developer; dwell times; temperature effects; re-running; interpretation of indications.
- 1.5 Equipment and control; Black lights and measurement of intensity; methods of control of contamination of penetrants, emulsifiers and developers; inspection area conditions.
- 1.6 The characteristics and terminology of defects arising from casting welding, heat treatment, fatigue and stress corrosion cracking.

### 2 Magnetic Particle Inspection Syllabus

- 2.1 Elementary theory of magnetism; Concepts of flux density, permeability, reluctance and the hysteresis loop.
- 2.2 Principles of magnetic particle testing; Theory, fields, current and demagnetization.
- 2.3 Method of magnetisation; Circular magnetisation by current flow, threading bar, induced current and longitudinal magnetisation by coil, magnetic flow.
- 2.4 Methods of establishment of flux density for inspection; The significant of reverse fields in coil magnetisation; characteristics of magnetisation by ac and dc.
- 2.5 Test procedures by continuous and residual methods; the application of wet and dry magnetic particles.

- 2.6 Characteristics and section of types of magnetic particle indicators; Methods of preparation of and the control of concentration of wet bath indicators; measurement of black light intensity.
- 2.7 The Applicability and Limitations of the Methods; Types of flaws and the interpretation of indications; factors governing sensitivity characteristics and sources of non-relevant indications.

### **3 Radiographic Inspection Syllabus**

- 3.1 Elementary theory; The properties, characteristics and generation of X and gamma rays including the electro-magnetic spectrum; monochromatic characteristic and bremsstrahlung radiation; propagation and inverse square law, absorption, scattering and the interaction of X-rays and matter.
- 3.2 Equipment; Principles of basic design and operation of X-ray generating equipment including the effects of voltage and amperage in the control of quality and intensity of radiation.
- 3.3 The principles of the method; the factors controlling sensitivity to the detection of cracking and corrosion including definition, contrast, alignment of the beam.
- 3.4 Basic technique; The relationship and interdependence of factors controlling definition and contrast including subject contrast, variation of absorption coefficient with quality of radiation, scatter, optimum film density, geometric unsharpness, focal spot size and geometric distribution in the beam, focus to object and focus to film distances.
- 3.5 The nature of X-ray; The properties and selection of films including characteristics curves, optimum density and film contrast amplification.
- 3.6 Screens; The principles, selection and use of metal and fluorescent screens.
- 3.7 The principles of film processing; The preparation, use and maintenance of film developing and fixing processes.
- 3.8 Exposure control; The preparation and use of exposure curves, the factors governing the selection of exposure including the voltage, milliamperage, film to focus distance and exposure time; the principles and use of filters; methods of minimising scattered radiation. Calculation for correct exposure. Relationship between SI units and non SI units in radiography.
- 3.9 Viewers and optimum conditions.
- 3.10 Interpretation; Types of flaws and their interpretation, the significance of image quality indicators, the characteristics and terminology of flaws arising from casting, welding, heat treatment, fatigue, stress corrosion cracking; the recognition of image quality degradation or spurious images caused by faulty film processing or handling.
- 3.11 The advantages and limitations of the method.

- 3.12 Radiation hazards and safety.
- 3.13 Methods of recording, reporting and identification and filing of radiographs.
- 3.14 General knowledge of aircraft structures, methods of manufacture and interpretation of engineering drawings. Construction of fuselages, empennages, centre sections, mainplanes, undercarriages and control surfaces. Identification of areas and locations i.e. station numbers.

#### **4 Ultra-sonic Inspection Syllabus**

- 4.1 Basic properties and nature of sound; The acoustic spectrum; frequency wave length and velocity relationship; propagation; acoustic impedance, reflection and impedance, mismatch, refraction, Snell's law; intensity, the decibel; attenuation by absorption and diffraction; types of sound waves and their characteristics. longitudinal, transverse, surface, plate and standing; factors affecting wave velocity; mode conversion at boundaries, acoustic coupling.
- 4.2 Generation of Ultrasonic Waves; The piezoelectric effects; electro-acoustic transducers, crystal thickness and resonant frequency, sound beam geometry, near zone and far zone characteristics, band width, pulsed beams, relative efficiencies of crystal types as transmitters and receivers - quartz, barium titanate, lithium sulphate, lead zirconate.
- 4.3 Probe Design; The ringing of a crystal, damping and the need for a short pulse length; types of probes and their construction, transceiver, combined, separate, focused; the dead zone.
- 4.4 The basis of the methods; The pulse echo and through transmission systems, resonance testing, immersion and contact scanning, the relationship between travel time of a reflected pulse and the position of the reflecting boundary, arithmetic of scanning and identification f echoes.
- 4.5 Instruments and equipment; The basic operation of the circuit of the pulse echo systems, the cathode ray tube, time base, pulse generation, pulse repetition frequency, amplifier gain, suppression, range, time delay, the significance of time base and receiver amplifier linearity, scale expansion; supplementary equipment, thickness gauge, flaw alarm, swept gain control, interface trigger, A, B and C scan presentations, rectified and unrectified trace.
- 4.6 Techniques: Surface preparation, the use of viscous couplants on rough surfaces, the necessity to remove uneven or poorly adhering paint and surface adherents such as heat treatment scale. The choice of transducer size and frequency as a function of the requirements of access, critical defect size, and minimal near zone length and beam divergence. The choice of shear wave refracted angle as a function of the geometry of the part under examination. The choice of overall test sensitivity and the use of standard reflectors and/or reference signals to confirm correct sensitivity. The IIW block, flat bottomed holes, the use of suppression and its effect on reflector area to signal height relationship. The use of defective parts or models containing artificial defect as test comparators. The estimation of defect size using comparative signal amplitude and surface plotting techniques. Factors governing amplitude of signals from defects. The reporting and recording of test results.

- 4.7 The characteristics and terminology of defects arising from casting, welding, heat treatment, fatigue, stress corrosion cracking.
- 4.8 A general knowledge of aircraft structures, methods of manufacture and interpretation of engineering drawings. Construction of fuselages, empennages, centre sections, mainplanes, undercarriages and controls surfaces. Identification of areas and locations i.e. station numbers.

## **5 Eddy Current Inspection Syllabus**

- 5.1 Basic principles of the method.
- 5.2 Basic theory of electricity and magnetism and induced eddy currents: direct current including simple circuits, alternating current including simple circuits, Ohms Law, Faraday's Law, Lenz's Law, power formulae, induction, inductance, capacitance, reactance, impedance, frequency, resonance, phase relationships; magnetic effect of current flow; magnetic field intensity, hysteresis loop, permeability; inducing eddy currents by coil. Concepts, definitions and units of measurement.
- 5.3 Factors to consider in eddy current testing: factors affecting the eddy current field; effective depth of penetration and factors affecting penetration, test coil information from impedance, coupling and phase changes.
- 5.4 Equipment and related applications: coil arrangements and types of coil; principles of probe design and construction principles; types of circuits including bridge, resonance and phase analysis, impedance change instruments. The selection, care, maintenance and calibration of equipment.
- 5.5 Techniques: probe characteristics and selection, probe field size to flaw size relationship. Factors affecting sensitivity including probe to test piece distance, angularity, edge effect contact pressure, conductive and non-conductive coating thickness, alloy composition variations, lift-off adjustment, signal/noise ratio, depth or skin effect. Design fundamentals of eddy current flaw standards and flaw detectability limitations.
- 5.6 Assessment of mechanical properties by the measurement of electrical conductivity; metallurgical factors affecting mechanical properties and electrical conductivity of heat treated aluminium alloys including alloy composition, size and distribution of precipitates. Variables affecting electrical conductivity measurements; thickness curvature, thickness of conducting and non-conducting coatings, temperature, precautions necessary for the assessment of heat affected aluminium alloys, e.g. fire damage. Conductivity standards.