



**Maldives Civil Aviation Authority**  
**Republic of Maldives**

**Acceptable Means of Compliance**

# **AMC-20 Airworthiness of Products, Parts and Appliances**

**Issue 1.00, 20 January 2025**

## Foreword

Maldives Civil Aviation Authority, in exercise of the powers conferred on it under Articles 5 and 6 of the Maldives Civil Aviation Authority Act 2/2012 has adopted this Acceptable Means of Compliance (AMC).

This AMC shall be cited as AMC-20 Airworthiness of Products, Parts and Appliances and shall come in to force on 20 January 2025.

Definitions of the terms and abbreviations used in this regulation, unless the context requires otherwise, are in MCAR-1 Definitions and Abbreviations.

AMCs illustrate a means, or several alternative means, but not necessarily the only possible means by which a requirement can be met.

'Guidance Material' (GM) helps to illustrate the meaning of a requirement.



**For the Civil Aviation Authority**  
Hussain Jaleel  
**Chief Executive**



## List of Effective Pages

<b>Subpart AMC</b>	<b>Page</b>	<b>Issue</b>	<b>Date</b>
List of Amendments		Issue: 1.00	20 Jan 2025
List of Effective Pages		Issue: 1.00	20 Jan 2025
Table of Contents		Issue: 1.00	20 Jan 2025
<b>A</b>			
AMC 20-6B	1-2	Issue: 1.00	20 Jan 2025
AMC 20-20B		Issue: 1.00	20 Jan 2025
AMC 20-21	3-122	Issue: 1.00	20 Jan 2025
AMC 20-22		Issue: 1.00	20 Jan 2025
AMC 20-24	123-136	Issue: 1.00	20 Jan 2025
AMC 20-25A		Issue: 1.00	20 Jan 2025
<b>B</b>			
List of AMCs		Issue: 1.00	20 Jan 2025

## Table of contents

Foreword .....	2
List of Amendments .....	3
List of Effective Pages .....	4
Table of contents .....	5
<b>SUBPART A — GENERAL</b> .....	<b>7</b>
<b>AMC 20-6B</b> .....	<b>7</b>
AMC 20-6B Extended-range operation with two-engine aeroplanes ETOPS certification and operation .....	7
<b>Chapter I GENERAL CONSIDERATIONS</b> .....	<b>7</b>
<b>Chapter II TYPE DESIGN APPROVAL CONSIDERATIONS</b> .....	<b>13</b>
<b>Chapter III OPERATIONAL APPROVAL CONSIDERATIONS</b> .....	<b>14</b>
Appendix 1 to AMC 20-6B – (Reserved) .....	27
Appendix 2 to AMC 20-6B – (Reserved) .....	27
Appendix 3 to AMC 20-6B – Operational limitations .....	27
Appendix 4 to AMC 20-6B – Flight preparation and in-flight procedures .....	29
Appendix 5 to AMC 20-6B – ETOPS en-route alternate aerodromes .....	35
Appendix 6 to AMC 20-6B – ETOPS training programme .....	37
Appendix 7 to AMC 20-6B – Typical ETOPS operations manual supplement .....	40
Appendix 8 to AMC 20-6B – Continuing airworthiness considerations .....	42
<b>AMC 20-20B</b> .....	<b>48</b>
AMC 20-20B Continuing structural integrity programme .....	48
Appendix 1 to AMC 20-20B (Reserved) .....	55
Appendix 2 to AMC 20-20B (Reserved) .....	55
Appendix 3 to AMC 20-20B Guidelines for establishing instructions for continued airworthiness of structural repairs and modifications .....	56
Annex 1 to Appendix 3 to AMC 20-20B (Reserved) .....	62
Annex 2 to Appendix 3 to AMC 20-20B (Reserved) .....	62
Annex 3 to Appendix 3 to AMC 20-20B (Reserved) .....	62
Annex 4 to Appendix 3 to AMC 20-20B (Reserved) .....	62
Annex 5 to Appendix 3 to AMC 20-20B List of major changes and STCs that may adversely affect fatigue-critical structure .....	63
Annex 6 to Appendix 3 to AMC 20-20B (Reserved) .....	63
Appendix 4 to AMC 20-20B Guidelines for the development of a corrosion prevention control programme .....	64
Appendix 5 to AMC 20-20B — (Reserved) .....	69
<b>AMC 20-21</b> .....	<b>70</b>

AMC 20-21 Programme to enhance aeroplane Electrical Wiring Interconnection System (EWIS) maintenance.....	70
Appendix A to AMC 20-21 (Reserved).....	86
Appendix B to AMC 20-21 (Reserved).....	86
Appendix C to AMC 20-21 (Reserved).....	86
Appendix D to AMC 20-21 (Reserved).....	86
Appendix E to AMC 20-21 Causes of Wire Degradation .....	87
<b>AMC 20-22 .....</b>	<b>89</b>
AMC 20-22 Aeroplane Electrical Wiring Interconnection System Training Programme.....	89
Appendix A to AMC 20-22 – EWIS Minimum Initial Training Programme for Group 1 and 2 .....	95
Appendix B to AMC 20-22 – EWIS Minimum Initial Training Programme for Group 3 through 8.....	97
Appendix C to AMC 20-22 – Curriculum and Lessons Plan .....	99
<b>AMC 20-24 .....</b>	<b>115</b>
AMC 20-24 Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter.....	115
Appendix 1 to AMC 20-24.....	132
Appendix 2 to AMC 20-24.....	133
Appendix 3 to AMC 20-24.....	134
Appendix 4 to AMC 20-24.....	135
<b>AMC 20-25A.....</b>	<b>138</b>
AMC 20-25A Airworthiness considerations for Electronic Flight Bags (EFBs)....	138
<b>SUBPART B — LIST OF AMC-20 ITEMS .....</b>	<b>148</b>

## **SUBPART A — GENERAL**

### **AMC 20-6B**

#### **AMC 20-6B Extended-range operation with two-engine aeroplanes ETOPS certification and operation**

##### **Chapter I GENERAL CONSIDERATIONS**

---

###### **SECTION 1: PURPOSE**

This AMC states an acceptable means but not the only means for obtaining approval for two-engine aeroplanes intended to be used in extended-range operations and for the performance of such operations.

Use of the terms *shall* and *must* apply only to an applicant who elects to comply with this AMC in order to obtain airworthiness approval or to demonstrate compliance with the operational criteria.

This AMC is structured in 3 chapters which contain the following information:

- Chapter I of this AMC provides general guidance and definitions related to extended-range operations.
- Chapter II of this AMC provides guidance on acceptable ETOPS type design approval of an engine or a particular aeroplane-engine combination. These aeroplanes may be used in extended-range operations.
- Chapter III of this AMC provides guidance to operators that seek ETOPS operational approval to conduct extended-range operations under the requirements of the applicable operational regulations.

###### **SECTION 2: RELATED REFERENCES**

MCAR-CAMO

MCAR-M

MCAR-Air Operations

###### **SECTION 3: ABBREVIATIONS**

**CAME:** continuing airworthiness management exposition

**CAMO:** continuing airworthiness management organisation approved pursuant to MCAR-CAMO

**CG:** centre of gravity

**IFSD:** in-flight shut-down

**MCT:** maximum continuous thrust

- RFFS** rescue and fire fighting services  
**(S)TC:** (supplemental) type certificate

#### **SECTION 4: TERMINOLOGY**

a. Approved One-Engine-Inoperative Cruise Speed

- (1) The approved one-engine-inoperative cruise speed for the intended area of operation must be a speed, within the certified limits of the aeroplane, selected by the operator and approved by the CAA.
- (2) The operator must use this speed in
  - (i) establishing the outer limit of the area of operation and any dispatch limitation,
  - (ii) calculation of single-engine fuel requirements under [Appendix 4](#) Section 4 to this AMC and,
  - (iii) establishing the level off altitude (net performance) data. This level off altitude (net performance) must clear any obstacle en-route by margins as specified in the operational requirements.

A speed other than the approved one-engine-inoperative-speed may be used as the basis for compliance with en-route altitude requirements.

The fuel required with that speed or the critical fuel scenario associated with the applicable ETOPS equal-time point, whichever is higher has to be uplifted.
- (3) As permitted in [Appendix 4](#) to this AMC, based on evaluation of the actual situation, the pilot-in-command may deviate from the planned one-engine-inoperative cruise speed.

Note: The diversion distance based on the approved one-engine-inoperative cruise speed may take into account the variation of the True Air Speed.

b. Dispatch

Dispatch is when the aircraft first moves under its own power for the purpose of taking off.

c. ETOPS Configuration, Maintenance and Procedures (CMP)

The ETOPS CMP document contains the particular airframe-engine combination configuration minimum requirements, including any special inspection, hardware life limits, master minimum equipment list (MMEL) constraints, operating and maintenance procedures found necessary by the State of Design to establish the suitability of an airframe/engine combination for extended-range operation.

d. ETOPS significant system

ETOPS Significant System means the aeroplane propulsion system and any other aeroplane system whose failure could adversely affect the safety of an ETOPS flight,



or whose functioning is important to continued safe flight and landing during an aeroplane diversion.

Each ETOPS significant system is either a Group 1 or Group 2 system based on the following criteria:

(1) *ETOPS Group 1 Systems:*

Group 1 Systems are ETOPS significant systems that, related to the number of engines on the aeroplane or the consequences of an engine failure, make the capability of the systems important for an ETOPS flight. The following provides additional discriminating definitions of an ETOPS Group 1 Significant System:

- (i) A system for which the fail-safe redundancy characteristics are directly linked to the number of engines (e.g. hydraulic system, pneumatic system, electrical system).
- (ii) A system that may affect the proper functioning of the engines to the extent that it could result in an in-flight shutdown or uncommanded loss of thrust (e.g. fuel system, thrust reverser or engine control or indicating system, engine fire detection system).
- (iii) A system which contributes significantly to the safety of an engine inoperative ETOPS diversion and is intended to provide additional redundancy to accommodate the system(s) lost by the inoperative engine. These include back-up systems such as an emergency generator, APU, etc.
- (iv) A system essential for prolonged operation at engine inoperative altitudes such as anti-icing systems for a two-engine aeroplane if single engine performance results in the aeroplane operating in the icing envelope.

(2) *ETOPS Group 2 Systems:*

Group 2 Systems are ETOPS significant systems that do not relate to the number of engines on the aeroplane but are important to the safe operation of the aeroplane on an ETOPS flight. The following provides additional discriminating definitions of an ETOPS Group 2 Significant System:

- (i) A system for which certain failure conditions would reduce the capability of the aeroplane or the ability of the crew to cope with an ETOPS diversion (e.g. long-range navigation or communication, equipment cooling, or systems important to safe operation on a ETOPS diversion after a decompression such as anti-icing systems).
- (ii) Time-limited systems including cargo fire suppression and oxygen if the ETOPS diversion is oxygen-system-duration-dependent.
- (iii) Systems whose failure would result in excessive crew workload or have operational implications or significant detrimental impact on the flight crew's or passengers' physiological well-being for an ETOPS diversion (e.g. flight control forces that would be exhausting for a maximum ETOPS

diversion, or system failures that would require continuous fuel balancing to ensure proper CG, or a cabin environmental control failure that could cause extreme heat or cold to the extent it could incapacitate the crew or cause physical harm to the passengers).

- (iv) A system specifically installed to enhance the safety of ETOPS operations and an ETOPS diversion regardless of the applicability of paragraphs (2)(i), (2)(ii) and (2)(iii) above (e.g. communication means).

e. Extended-Range Entry Point

The extended-range entry point is the first point on the aeroplane's route which is:

- For two-engine aeroplanes with a maximum approved passenger seating configuration of 20 or more, at 60 minutes flying time at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate aerodrome.
- For two-engine aeroplanes with a maximum approved passenger seating configuration of 19 or less, at 180 minutes flying time at the approved one-engine-inoperative speed (in still air) from an adequate aerodrome.

f. In-flight Shutdown (IFSD)

In-flight shutdown (IFSD) occurs when an engine ceases to function and is shut down, whether self-induced, flight crew initiated or caused by an external influence. For ETOPS, all IFSDs occurring from take-off decision speed until touch-down shall be counted.

CAA considers IFSD for all causes, for example: flameout, internal failure, flight-crew-initiated shutdown, foreign object ingestion, icing, inability to obtain or control desired thrust or power, and cycling of the start control, however briefly, even if the engine operates normally for the remainder of the flight.

This definition excludes the cessation of the functioning of an engine when immediately followed by an automatic engine relight and when an engine does not achieve desired thrust or power but is not shut down. These events as well as engine failures occurring before take-off decision speed or after touchdown, although not counted as IFSDs, shall be reported to the CAA in the frame of continued airworthiness for ETOPS.

g. Maximum Approved Diversion Time

A maximum approved diversion time(s) for the airframe/engine combination or the engine, established in accordance with the type design. This maximum approved diversion time(s) is reflected in the aeroplane and engine type certificate data sheets or (S)TC and in the AFM or AFM-supplement.

h. Operator's Approved Diversion Time

Operator's approved diversion time is the maximum time authorised by the CAA that the operator can operate a type of aeroplane at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate aerodrome for the area of operation.

i. System:

A system includes all elements of equipment necessary for the control and performance of a particular function. It includes both the equipment specifically provided for the function in question and other basic equipment such as that necessary to supply power for the equipment operation.

- (1) Airframe System. Any system on the aeroplane that is not part of the propulsion system.
- (2) Propulsion System. The aeroplane propulsion system includes the engine and each component that is necessary for propulsion; components that affect the control of the propulsion units; and components that affect the safe operation of the propulsion units.

## SECTION 5: CONCEPTS

Although it is self-evident that the overall safety of an extended-range operation cannot be better than that provided by the reliability of the propulsion systems, some of the factors related to extended-range operation are not necessarily obvious.

For example, cargo compartment fire suppression/containment capability could be a significant factor, or operational/maintenance practices may invalidate certain determinations made during the aeroplane type design certification or the probability of system failures could be a more significant problem than the probability of propulsion system failures. Although propulsion system reliability is a critical factor, it is not the only factor which should be seriously considered in evaluating extended-range operation. Any decision relating to extended-range operation with two-engine aeroplanes should also consider the probability of occurrence of any conditions which would reduce the capability of the aeroplane or the ability of the crew to cope with adverse operating conditions.

The following is provided to define the concepts for evaluating extended-range operation with two-engine aeroplanes. This approach ensures that the level of safety of extended-range operation with two-engine aeroplanes is consistent with the level of safety required for current extended-range operation with three and four-engine turbine powered aeroplanes without unnecessarily restricting operation.

a. Airframe Systems

A number of airframe systems have an effect on the safety of extended range operation; therefore, the type design certification of the aeroplane should be reviewed to ensure that the design of these systems is acceptable for the safe conduct of the intended operation.

b. Propulsion Systems

In order to maintain a level of safety consistent with the overall safety level achieved by modern aeroplanes, it is necessary for two-engine aeroplanes used in extended-range operation to have an acceptably low risk of significant loss of power/thrust for all design- and operation-related causes.

c. Maintenance and Reliability Programme Definition

Since the quality of maintenance and reliability programmes can have an appreciable effect on the reliability of the propulsion system and the airframe systems required for extended-range operation, an assessment should be made of the proposed maintenance and reliability programme's ability to maintain a satisfactory level of propulsion and airframe system reliability for the particular airframe/engine combination.

d. Maintenance and Reliability Programme Implementation

Following a determination that the airframe systems and propulsion systems are designed to be suitable for extended-range operation, an in-depth review of the applicant's training programmes, operations and maintenance and reliability programmes should be accomplished to show ability to achieve and maintain an acceptable level of systems reliability to safely conduct these operations.

e. Human Factors

System failures or malfunctions occurring during extended-range operation could affect flight crew workload and procedures. Since the demands on the flight crew may increase, an assessment should be made to ensure that more than average piloting skills or crew co-ordination is not required.

## **Chapter II TYPE DESIGN APPROVAL CONSIDERATIONS**

---

The CAA does not issue ETOPS type design approvals but looks for evidence that the type of the aeroplane is eligible for extended range operations which must be reflected by a statement in the approved AFM and the type certificate data sheet that is accepted in accordance with MCAR-21 Subpart B.

## **Chapter III OPERATIONAL APPROVAL CONSIDERATIONS**

---

### **SECTION 1: APPLICABILITY**

This acceptable means of compliance is for operators seeking an ETOPS operational approval to operate:

- (1) Two-engine aeroplanes with a maximum passenger seating configuration of 20 or more, in excess of 60 minutes at the approved one-engine-inoperative speed (under standard conditions in still air) from an adequate aerodrome;
- (2) or Two-engine aeroplanes with a maximum passenger seating configuration of 19 or less, in excess of 180 minutes at the approved one-engine-inoperative speed (in still air) from an adequate aerodrome.

### **SECTION 2: (Reserved)**

### **SECTION 3: APPLICABLE OPERATIONAL REQUIREMENTS**

This chapter details the approval process required for ETOPS in accordance with the operational requirements.

### **SECTION 4: METHODS FOR OBTAINING ETOPS OPERATIONS APPROVAL**

There are two methods for obtaining an ETOPS approval, depending on the availability and amount of prior experience with the candidate airframe/engine combination:

- 'Accelerated ETOPS approval' that does not require prior in-service experience with the candidate airframe/engine combination;
- 'In-service ETOPS Approval', based on a prerequisite amount of prior in-service experience with the candidate airframe/engine combination. Elements from the 'accelerated ETOPS approval' method may be used to reduce the amount of prior in-service experience.

### **SECTION 5: ACCELERATED ETOPS APPROVAL**

The assessment of an operator's suitability to be granted an ETOPS Approval is routinely made after a 12 month period of operating the nominated airframe/engine combination on non-ETOPS routes. However, in some cases it may not be feasible, because of the nature of the operation, for an operator to complete this 12 month period on non-ETOPS routes and the purpose of this Section is to give guidance to an operator as to how an ETOPS Operational Approval with reduced in-service experience may be obtained.

The criteria defined in this section permit approval of ETOPS operations up to 120 minutes, when the operator has established that those processes that are necessary for successful ETOPS are in place and are proven to be reliable. The basis of the accelerated approval is that the operator will meet equivalent levels of safety and satisfy the objectives of this AMC.

Operators who successfully demonstrate a capability consistent with the standards required for an Operational Approval with a rule time of 120 minutes may be required to progress to this level of approval by the steps specified below.

- a. Operators who have previous ETOPS experience with similar technology aeroplanes and similar technology engines can apply for a 120 minute rule time Operational Approval at Entry into Service (EIS) of the new type.
- b. Operators who have previous long range experience and experience with similar technology aeroplanes and similar technology engines can apply for a 90 minute Approval at EIS and must satisfactorily complete a three month period and a minimum of 100 sectors before progressing to a 120 minute Approval.
- c. Operators who have no previous long range experience but obtain appropriate maintenance and operational support from an established ETOPS Approved organisation can apply for a 90 minute Approval and must satisfactorily complete a three month period and a minimum of 100 sectors before progressing to a 120 minute Approval.
- d. Operators who intend to commence ETOPS operations with personnel who have gained appropriate experience with other ETOPS Approved operators can apply for a 75 minute Approval and must satisfactorily complete a three month period and 100 sectors before progressing to a 90 minute Approval and they must satisfactorily complete a further three month period and 100 sectors before progressing to a 120-minute Approval.

The accelerated ETOPS approval process includes the following phases:

- Application phase
- Validation of the operator's ETOPS processes
- Validation of operator ETOPS continuing airworthiness and operations capability
- Issue of ETOPS operations approval by the CAA

### 5.1 Application phase

The operator should submit an accelerated ETOPS operations approval plan to the CAA 6 months, but never later than 3 months, before the proposed start of ETOPS. This time will permit the CAA to review the documented plans and ensure adequate ETOPS processes are in place.

#### (A) Accelerated ETOPS operations approval plan:

The accelerated ETOPS operations approval plan should define:

1. The proposed routes and the ETOPS diversion time necessary to support those routes;

2. The proposed one-engine-inoperative cruise speed, which may be area-specific depending upon anticipated aeroplane loading and likely fuel penalties associated with the planned procedures;
3. How to comply with the ETOPS Processes listed in paragraph (B);
4. The resources allocated to each ETOPS process to initiate and sustain ETOPS operations in a manner that demonstrates commitment by management and all personnel involved in ETOPS continuing airworthiness and operational support;
5. How to establish compliance with the build standard required for type design approval, e.g. CMP document compliance;
6. Review gates: A review gate is a milestone of the tracking plan to allow for the orderly tracking and documentation of specific provisions of this section. Normally, the review gate process will start 6 months before the proposed start of ETOPS and should continue until at least 6 months after the start of ETOPS. The review gate process will help ensure that the proven processes comply with the provisions of this AMC and are capable of continued ETOPS operations.

(B) Operator ETOPS process elements

The operator that seeks Accelerated ETOPS operations approval should also demonstrate to the CAA that it has established an ETOPS process that includes the following ETOPS elements:

1. Airframe/engine combination and engine compliance with ETOPS Type Design Build Standard (CMP);
2. Compliance with the continuing airworthiness requirements as defined in [Appendix 8](#), which should include:
  - a. A maintenance programme;
  - b. A proven ETOPS reliability programme;
  - c. A proven oil consumption monitoring programme;
  - d. A proven engine condition monitoring and reporting system;
  - e. A propulsion system monitoring programme;
  - f. An ETOPS parts control programme;
  - g. A proven plan for resolution of aeroplane discrepancies.
3. ETOPS Operations Manual supplement or its equivalent in the Operations Manual;
4. The operator should establish a programme that results in a high degree of confidence that the propulsion system reliability that is appropriate to the ETOPS diversion time would be maintained;



5. Initial and recurrent training and qualification programmes in place for ETOPS related personnel, including flight crew and all other operations personnel;
6. Compliance with the Flight Operations Programme as defined in this AMC;
7. Proven flight planning and dispatch programmes that are appropriate to ETOPS;
8. Procedures to ensure the availability of meteorological information and MEL that are appropriate to ETOPS; and
9. Flight crew and dispatch personnel familiar with the ETOPS routes to be flown; in particular, the requirements for, and selection of ETOPS en-route alternate aerodromes.

(C) Process elements documentation:

Documentation should be provided for the following elements:

1. Technology that is new to the operator and significant differences in ETOPS significant systems (engines, electrical, hydraulic and pneumatic), compared to the aeroplanes currently operated and the aeroplane for which the operator is seeking Accelerated ETOPS operations approval;
2. The plan to train the flight and continuing airworthiness personnel to the different ETOPS process elements;
3. The plan to use proven or manufacturer-validated training and maintenance and operations manual procedures relevant to ETOPS for the aeroplane for which the operator is seeking accelerated ETOPS operations approval;
4. Changes to any previously proven or manufacturer-validated training, maintenance or operations manual procedures described above. Depending on the nature of any changes, the operator may be required to provide a plan for validating such changes;
5. The validation plan for any additional operator unique training and procedures relevant to ETOPS, if any;
6. Details of any ETOPS support programme from the airframe/engine combination or engine (S)TC holder, other operators or any third-country authority; and
7. The control procedures when a contracted maintenance organisation or flight dispatch organisation is used.

## 5.2 Validation of the operator's ETOPS processes

This section identifies process elements that need to be validated and approved prior to the start of accelerated ETOPS. For a process to be considered proven, the process should first be described, including a flow chart of process elements. The roles and responsibilities of the personnel that manage the process should be defined including any training requirement. The operator should demonstrate that the process is in place and functions as intended. This may be accomplished by providing data, documentation and analysis results and/or by demonstrating in practise that the process works and consistently provides the intended results. The operator should also demonstrate that a feedback loop exists to facilitate the surveillance of the process, based on in-service experience.

If any operator is currently approved for conducting ETOPS with a different engine and/or airframe/engine combination, it may be able to document proven ETOPS processes. In this case, only minimal further validation may be necessary. It will be necessary to demonstrate that processes are in place to assure equivalent results on the engine and/or airframe/engine combination being proposed for Accelerated ETOPS Operations Approval.

(A) Reduction in the validation requirements:

The following elements will be useful or beneficial in justifying a reduction by the CAA in the validation requirements of ETOPS processes:

1. Experience with other airframes and/or engines;
2. Previous ETOPS experience;
3. Experience with long-range, over-water operations with two, three or four engine aeroplanes;
4. Any experience gained by flight crews, continuing airworthiness personnel and flight dispatch personnel, while working with other ETOPS approved operators, particularly when such experience is with the same airframe or airframe/engine combination.

Process validation may be done on the airframe/engine combination, which will be used in Accelerated ETOPS operation or on a different aeroplane type than that for which approval is being sought.

(B) Validation programme:

A process could be validated by demonstrating that it produces equivalent results on a different aeroplane type or airframe/engine combination. In this case, the validation programme should address the following:

1. The operator should show that the ETOPS validation programme can be executed in a safe manner;
2. The operator should state in its application any policy guidance to personnel involved in the ETOPS process validation programme. Such guidance should clearly state that ETOPS process validation exercises should not be allowed to adversely impact the safety of actual

operations, especially during periods of abnormal, emergency, or high cockpit workload operations. It should emphasise that during periods of abnormal or emergency operation or high cockpit workload ETOPS process validation exercises may be terminated;

3. The validation scenario should be of sufficient frequency and operational exposure to validate maintenance and operational support systems not validated by other means;
4. A means should be established to monitor and report performance with respect to accomplishment of tasks associated with ETOPS process elements. Any recommended changes that result from the validation programme to ETOPS continuing airworthiness and/or operational process elements should be defined.

(C) Documentation requirements for the process validation

The operator should:

1. document how each element of the ETOPS process was utilised during the validation;
2. document any shortcomings with the process elements and measures in place to correct such shortcomings;
3. document any changes to ETOPS processes, which were required after an in-flight shutdown (IFSD), unscheduled engine removals, or any other significant operational events;
4. provide periodic process validation reports to the CAA (this may be addressed during review gates).

(D) Validation programme information

Prior to the start of the validation process, the following information should be submitted to the CAA:

1. Validation periods, including start dates and proposed completion dates;
2. Definition of aeroplane to be used in the validation (the list should include registration numbers, manufacturer and serial number and model of the airframe and engines);
3. Description of the areas of operation (if relevant to validation) proposed for validation and actual operations;
4. Definition of designated ETOPS validation routes. The routes should be of duration required to ensure necessary process validation occurs;
5. Process validation reporting. The operator should compile results of ETOPS process validation.

### 5.3 Validation of operator ETOPS continuing airworthiness and operations capability

The operator should demonstrate competence to safely conduct and adequately support the intended operation. Prior to ETOPS approval, the operator should demonstrate that the ETOPS continuing airworthiness processes are being properly conducted.

The operator should also demonstrate that ETOPS flight dispatch and release practices, policies, and procedures are established for operations.

An operational validation flight may be required so that the operator can demonstrate dispatch and normal in-flight procedures. The content of this validation flight will be determined by the CAA based on the previous experience of the operator.

Upon successful completion of the validation flight, when required, the operator should modify the operational manuals to include approval for ETOPS as applicable

### 5.4 ETOPS operations approval issued by the CAA

Operations approvals granted with reduced in-service experience may be limited to those areas determined by the CAA at time of issue. An application for a change is required for new areas to be added.

The approval issued by the CAA for ETOPS up to 120 minutes will be based on the information required in [Appendix 3](#) Section 3.

## SECTION 6: IN-SERVICE ETOPS APPROVAL

Approval based on in-service experience on the particular airframe/engine combination.

### 6.1 Application

Any operator applying for ETOPS approval should submit a request, with the required supporting data, to the CAA at least 3 months prior to the proposed start of ETOPS with the specific airframe/engine combination.

### 6.2 Operator experience

Each operator seeking approval via the in-service route should provide a report to the CAA, indicating the operator's capability to maintain and operate the specific airframe/engine combination for the intended extended-range operation. This report should include experience with the engine type or related engine types, experience with the aeroplane systems or related aeroplane systems, or experience with the particular airframe/engine combination on non-extended range routes. Approval would be based on a review of this information.

Each operator that requests Approval to conduct ETOPS beyond 180 minutes should already have ETOPS experience and hold a 180-minute ETOPS approval.

Note 1: The operator's authorised maximum diversion time may be progressively increased by the CAA as the operator gains experience on the particular airframe/engine combination. Not less than 12 consecutive months experience will

normally be required before authorisation of ETOPS up to 180 minutes maximum diversion time, unless the operator can demonstrate compensating factors. The factors to consider may include duration of experience, total number of flights, operator's diversion events, record of the airframe/engine combination with other operators, quality of operator's programmes and route structure. However, the operator will still need, in the latter case, to demonstrate the capability to maintain and operate the new airframe/engine combination at a similar level of reliability.

In considering an application from an operator to conduct extended-range operations, an assessment should be made of the operator's overall safety record, past performance, flight crew training and experience, and maintenance programme. The data provided with the request should substantiate the operator's ability and competence to safely conduct and support these operations and should include the means used to satisfy the considerations outlined in this paragraph. (Any reliability assessment obtained, either through analysis or service experience, should be used as guidance in support of operational judgements regarding the suitability of the intended operation.)

### 6.3 Assessment of the operator's propulsion system reliability

Following the accumulation of adequate operating experience by the world fleet of the specified airframe/engine combination and the established IFSD rate objective for use in ensuring the propulsion system reliability necessary for extended-range operations, an assessment should be made of the applicant's ability to achieve and maintain this level of propulsion system reliability.

This assessment should include trend comparisons of the operator's data with other operators as well as the world fleet average values, and the application of a qualitative judgement that considers all the relevant factors. The operator's past record of propulsion system reliability with related types of power units should also be reviewed, as well as its record of achieved systems reliability with the airframe/engine combination for which authorisation is sought to conduct extended-range operations.

Note: Where statistical assessment alone may not be applicable, e.g. when the fleet size is small, the applicant's experience will be reviewed on a case-by-case basis.

### 6.4 Validation of operator ETOPS continuing airworthiness and operations capability

The operator should demonstrate competence to safely conduct and adequately support the intended operation. Prior to ETOPS approval, the operator should demonstrate that the ETOPS continuing airworthiness processes are being properly conducted.

The operator should also demonstrate that ETOPS flight dispatch and release practices, policies, and procedures are established for operations.

An operational validation flight may be required so that the operator can demonstrate dispatch and normal in-flight procedures. The content of this validation flight will be determined by the CAA based on the previous experience of the operator.

Upon successful completion of a validation flight, where required, the operational specifications and manuals should be modified accordingly to include approval for ETOPS as applicable.

#### 6.5 ETOPS operations approval issued by the CAA

Operations approvals based on in-service experience are limited to those areas agreed by the CAA at time of issue. Additional approval is required for new areas to be added.

The approval issued by the CAA for ETOPS should specifically include provisions as described in [Appendix 3](#) Section 4.

### SECTION 7: ETOPS APPROVAL CATEGORIES

There are four approval categories:

- Approval for 90 minutes or less diversion time
- Approval for diversion time above 90 minutes up to 180 minutes
- Approval for diversion time above 180 minutes
- Approval for diversion times above 180 minutes of operators of two-engine aeroplanes with a maximum passenger seating configuration of 19 or less

An operator that seeks ETOPS approval in one of the above categories should comply with the requirements that are common to all categories and the specific requirements of the particular category for which approval is sought.

#### 7.1 REQUIREMENTS COMMON TO ALL ETOPS APPROVAL CATEGORIES:

(i) Continuing Airworthiness

The operator should comply with the continuing airworthiness considerations of [Appendix 8](#).

(ii) Release Considerations

(A) Minimum equipment list (MEL)

Aeroplanes should only be operated in accordance with the provisions of the approved minimum equipment list (MEL).

(B) Weather

To forecast terminal and en-route weather, an operator should only use weather information systems that are sufficiently reliable and accurate in the proposed area of operation.

(C) Fuel

Fuel should be sufficient to comply with the critical fuel scenario as described in [Appendix 4](#) to this AMC.

(iii) Flight Planning

The effects of wind and temperature at the one-engine-inoperative cruise altitude should be accounted for in the calculation of equal-time point. In addition to the nominated ETOPS en-route alternates, the operator should provide flight crews with information on adequate aerodromes on the route to be flown which are not forecast to meet the ETOPS en-route alternate weather minima. Aerodrome facility information and other appropriate planning data concerning these aerodromes should be provided before commencement of the flight to flight crews for use when executing a diversion.

(iv) Flight Crew Training

The operator's ETOPS training programme should provide initial and recurrent training for flight crew in accordance with [Appendix 6](#).

(v) En-route Alternate

[Appendix 5](#) to this AMC should be implemented when establishing the company operational procedures for ETOPS.

(vi) Communications Equipment (VHF/HF, Data Link, Satellite Communications)

For all routes where voice communication facilities are available, the communication equipment required by operational requirements should include at least one voice-based system.

## 7.2 SPECIFIC REQUIREMENTS:

### 7.2.1 APPROVAL FOR 90 MINUTES OR LESS DIVERSION TIME

The operator's approved diversion time is an operational limit that should not exceed either:

- the maximum approved diversion time, or
- the time-limited system capability minus 15 minutes.

Consideration may be given to the approval of ETOPS up to 90 minutes for operators with minimal or no in-service experience with the airframe/engine combination. This determination considers such factors as the proposed area of operations, the operator's demonstrated ability to successfully introduce aeroplanes into operations and the quality of the proposed continuing airworthiness and operations programmes.

Minimum equipment list (MEL) restrictions for 120 minutes ETOPS should be used unless there are specific restrictions for 90 minutes or less.

### 7.2.2 APPROVAL FOR DIVERSION TIME ABOVE 90 MINUTES UP TO 180 MINUTES

Prior to approval, the operator's capability to conduct operations and implement effective ETOPS programmes, in accordance with the criteria detailed in this AMC and the relevant appendices, will be examined.

The operator's approved diversion time is an operational limit that should not exceed either:

- the maximum approved diversion time, or
  - the time-limited system capability minus 15 minutes.
- i) (Reserved)
  
  - ii) (Reserved)

### 7.2.3 APPROVAL FOR DIVERSION TIME ABOVE 180 MINUTES

Approval to conduct operations with diversion times exceeding 180 minutes may be granted to operators with previous ETOPS experience on the particular engine/airframe combination and an existing 180-minute ETOPS approval on the airframe/engine combination listed in their application.

Operators should minimise diversion time along the preferred track. Increases in diversion time by disregarding ETOPS adequate aerodromes along the route should only be planned in the interest of the overall safety of the operation.

The approval to operate more than 180 minutes from an adequate aerodrome shall be area-specific, based on the availability of adequate ETOPS en-route alternate aerodromes.

(i) Operating limitations

In view of the long diversion time involved (above 180 minutes), the operator is responsible for ensuring at flight planning stage, that on any given day in the forecast conditions, such as prevailing winds, temperature and applicable diversion procedures, a diversion to an ETOPS en-route alternate aerodrome will not exceed the:

- (A) Engine-related time-limited systems capability minus 15 minutes at the approved one-engine-inoperative cruise speed; and
- (B) Non-engine-related time-limited system capability minus 15 minutes, such as cargo fire suppression, or other non-engine-related system capability at the all-engine-operative cruise speed.

(ii) Communications Equipment (VHF/HF, Data Link and Satellite-based communications)

Operators should use any or all these forms of communications to ensure communications capability when operating ETOPS in excess of 180 minutes.



#### 7.2.4 APPROVAL FOR DIVERSION TIMES ABOVE 180 MINUTES OF OPERATORS OF TWO-ENGINE AEROPLANES WITH A MAXIMUM PASSENGER SEATING CONFIGURATION OF 19 OR LESS AND A MAXIMUM TAKE-OFF MASS LESS THAN 45 360 KG

(i) Type Design

The airframe/engine combination should have the appropriate type design approval for the requested maximum diversion times in accordance with Chapter II.

(ii) Operations Approval

Approval to conduct operations with diversion times exceeding 180 minutes may be granted to operators with experience on the particular airframe/engine combination or existing ETOPS approval on a different airframe/engine combination, or equivalent experience. Operators should minimise diversion time along the preferred track to 180 minutes or less whenever possible. The approval to operate more than 180 minutes from an adequate aerodrome shall be area-specific, based on the availability of alternate aerodromes, the diversion to which would not compromise safety.

Note: Exceptionally for this type of aeroplanes, operators may use the accelerated ETOPS approval method to gain ETOPS approval. This method is described in Section 5.

### **SECTION 8: ETOPS OPERATIONS MANUAL SUPPLEMENT**

The ETOPS Operations Manual supplement or its equivalent material in the Operations Manual, and any subsequent amendments, are subject to approval by the CAA.

The CAA will review the actual ETOPS in-service operation. Amendments to the Operations Manual may be required as a result. Operators should provide information for and participate in such reviews, with reference to the (S)TC holder where necessary. The information resulting from these reviews should be used to modify or update flight crew training programmes, operations manuals and checklists, as necessary.

An example outline of ETOPS Operations Manual Supplement content is provided in [Appendix 7](#) to this AMC.

### **SECTION 9: FLIGHT PREPARATION AND IN-FLIGHT PROCEDURES**

The operator should establish pre-flight planning and dispatch procedures for ETOPS and they should be listed in the Operations Manual. These procedures should include, but not be limited to, the gathering and dissemination of forecast and actual weather information, both along the route and at the proposed ETOPS alternate aerodromes. Procedures should also be established to ensure that the requirements of the critical fuel scenario are included in the fuel planning for the flight.

The procedures and manual should require that sufficient information is available for the aeroplane pilot-in-command, to satisfy him or her that the status of the aeroplane and relevant airborne systems is appropriate for the intended operation. The manual should also include guidance on diversion decision-making and en-route weather monitoring.

Additional guidance on the content of the 'Flight preparation and in-flight procedures' section of the Operations Manual is provided in [Appendix 4](#) to this AMC.

#### **SECTION 10: OPERATIONAL LIMITATIONS**

The operational limitations to the area of operations and the Operator's approved diversion time are detailed in [Appendix 3](#) to this AMC – 'Operational Limitations'.

#### **SECTION 11: ETOPS EN-ROUTE ALTERNATE AERODROMES**

An operator should select ETOPS en-route alternate aerodromes in accordance with the applicable operational requirements and [Appendix 5](#) to this AMC – En-route alternate.

#### **SECTION 12: INITIAL/RECURRENT TRAINING**

An operator should ensure that prior to conducting ETOPS, each crew member has completed successfully ETOPS training and checking in accordance with a syllabus compliant with [Appendix 7](#) to this AMC, approved by the CAA and detailed in the Operations Manual.

This training should be type- and area-specific in accordance with the applicable operational requirements.

The operator should ensure that crew members are not assigned to operate ETOPS routes for which they have not successfully passed the training.

#### **SECTION 13: CONTINUING SURVEILLANCE**

The fleet-average IFSD rate for the specified airframe/engine combination will continue to be monitored in accordance with [Appendix 8](#). As with all other operations, the CAA will also monitor all aspects of the extended-range operations that it has authorised to ensure that the levels of reliability achieved in extended-range operations remain at the necessary levels determined during type design approval, and that the operation continues to be conducted safely. In the event that an acceptable level of reliability is not maintained, if significant adverse trends exist, or if significant deficiencies are detected in the type design or the conduct of the ETOPS operation, then the CAA will initiate a special evaluation, impose operational restrictions if necessary, and stipulate corrective action for the operator to adopt in order to resolve the problems in a timely manner. The CAA will alert the certification authority when a special evaluation is initiated and make provisions for their participation.

## **Appendix 1 to AMC 20-6B – (Reserved)**

## **Appendix 2 to AMC 20-6B – (Reserved)**

## **Appendix 3 to AMC 20-6B – Operational limitations**

---

### **1. AREA OF OPERATION**

An operator is, when specifically approved, authorised to conduct ETOPS flights within an area where the diversion time, at any point along the proposed route of flight, to an adequate ETOPS en-route alternate aerodrome is within the operator's approved diversion time (under standard conditions in still air) at the approved one-engine-inoperative cruise speed.

### **2. OPERATOR'S APPROVED DIVERSION TIME**

The procedures established by the operator should ensure that ETOPS is only planned on routes where the operator's approved diversion time to an adequate ETOPS en-route alternate aerodrome can be met.

### **3. ISSUE OF THE ETOPS OPERATIONS APPROVAL BY THE CAA**

The approval issued by the CAA for ETOPS operations will be based on the following information provided by the operator:

- a. Specification of the particular airframe/engine combinations, including the current approved CMP document required for ETOPS as normally identified in the AFM;
- b. Authorised area of operation;
- c. Minimum altitudes to be flown along planned and diversionary routes;
- d. Operator's approved diversion time;
- e. Aerodromes identified to be used, including alternates, and associated instrument approaches and operating minima;
- f. The approved maintenance and reliability programme for ETOPS;
- g. Identification of those aeroplanes designated for ETOPS by make and model as well as serial number and registration;
- h. Specification of routes and the ETOPS diversion time necessary to support those routes;
- i. The one-engine-inoperative cruise speed, which may be area-specific, depending upon anticipated aeroplane loading and likely fuel penalties associated with the planned procedures;
- j. Processes and related resources allocated to initiate and sustain ETOPS operations in a manner that demonstrates commitment by management and

- all personnel involved in ETOPS continued airworthiness and operational support;
- k. The plan for establishing compliance with the build standard required for type design approval, e.g. CMP document compliance.

## **Appendix 4 to AMC 20-6B – Flight preparation and in-flight procedures**

---

### **1. GENERAL**

The flight release considerations specified in this paragraph are in addition to the applicable operational requirements. They specifically apply to ETOPS. Although many of the considerations in this AMC are currently incorporated into approved programmes for other aeroplanes or route structures, the unique nature of ETOPS necessitates a re-examination of these operations to ensure that the approved programmes are adequate for this purpose.

### **2. MINIMUM EQUIPMENT LIST (MEL)**

The system redundancy levels appropriate to ETOPS should be reflected in the master minimum equipment list (MMEL). An operator's MEL may be more restrictive than the MMEL considering the kind of ETOPS operation proposed, equipment and in-service problems unique to the operator. Systems and equipment considered to have a fundamental influence on safety may include, but are not limited to, the following:

- a. electrical;
- b. hydraulic;
- c. pneumatic;
- d. flight instrumentation, including warning and caution systems;
- e. fuel;
- f. flight control;
- g. ice protection;
- h. engine start and ignition;
- i. propulsion system instruments;
- j. navigation and communications, including any route specific long-range navigation and communication equipment;
- k. auxiliary power-unit;
- l. air conditioning and pressurisation;
- m. cargo fire suppression;
- n. engine fire protection;
- o. emergency equipment;
- p. systems and equipment required for engine condition monitoring.

In addition, the following systems are required to be operative for dispatch for ETOPS with diversion times above 180 minutes:

- q. Fuel quantity indicating system (FQIS);
- r. APU (including electrical and pneumatic supply to its designed capability), if necessary to comply with ETOPS requirements;

- s. Automatic engine or propeller control system;
- t. Communication system(s) relied on by the flight crew to comply with the requirement for communication capability.

### **3. COMMUNICATION AND NAVIGATION FACILITIES**

For releasing an aeroplane on an ETOPS flight, the operators should ensure that:

- a. Communications facilities are available to provide under normal conditions of propagation at all planned altitudes of the intended flight and the diversion scenarios, reliable two-way voice and/or data link communications;
- b. Visual and non-visual aids are available at the specified alternates for the anticipated types of approaches and operating minima.

### **4. FUEL SUPPLY**

- a. General

For releasing an aeroplane on an ETOPS flight, the operators should ensure that it carries sufficient fuel and oil to meet the applicable operational requirements and any additional fuel that may be determined in accordance with this Appendix.

- b. Critical fuel reserve

In establishing the critical fuel reserves, the applicant is to determine the fuel necessary to fly to the most critical point (at normal cruise speed and altitude, taking into account the anticipated meteorological conditions for the flight) and execute a diversion to an ETOPS en-route alternate under the conditions outlined in this Appendix, the 'Critical Fuel Scenario' (paragraph c. below).

These critical fuel reserves should be compared to the normal applicable operational requirements for the flight. If it is determined by this comparison that the fuel to complete the critical fuel scenario exceeds the fuel that would be on board at the most critical point, as determined by applicable operational requirements, additional fuel should be included to the extent necessary to safely complete the Critical Fuel Scenario. When considering the potential diversion distance flown, account should be taken of the anticipated routing and approach procedures, in particular any constraints caused by airspace restrictions or terrain.

- c. Critical fuel scenario

The following describes a scenario for a diversion at the most critical point. The applicant should confirm compliance with this scenario when calculating the critical fuel reserve necessary.

Note 1: If an APU is one of the required power sources, then its fuel consumption should be accounted for during the appropriate phases of flight.

Note 2: Additional fuel consumptions due to any MEL or CDL items should be accounted for during the appropriate phases of flight, when applicable.

The aeroplane is required to carry sufficient fuel taking into account the forecast wind and weather to fly to an ETOPS route alternate assuming the greater of:

- (1) A rapid decompression at the most critical point followed by descent to a 10 000 ft or a higher altitude if sufficient oxygen is provided in accordance with the applicable operational requirements.
- (2) A flight at the approved one-engine-inoperative cruise speed assuming a rapid decompression and a simultaneous engine failure at the most critical point followed by descent to a 10 000 ft or a higher altitude if sufficient oxygen is provided in accordance with the applicable operational requirements.
- (3) A flight at the approved one-engine-inoperative cruise speed assuming an engine failure at the most critical point followed by descent to the one-engine-inoperative cruise altitude.

Upon reaching the alternate, hold at 1 500 ft above field elevation for 15 minutes and then conduct an instrument approach and landing.

Add a 5 % wind speed factor (i.e. an increment to headwind or a decrement to tailwind) on the actual forecast wind used to calculate fuel in the greater of (1), (2) or (3) above to account for any potential errors in wind forecasting. If an operator is not using the actual forecast wind based on wind model acceptable to the CAA, allow 5% of the fuel required for (1), (2) or (3) above, as reserve fuel to allow for errors in wind data. A wind aloft forecasting distributed worldwide by the World Area Forecast System (WAFS) is an example of a wind model acceptable to the CAA.

d. Icing

Correct the amount of fuel obtained in paragraph c. above taking into account the greater of:

- (1) the effect of airframe icing during 10 % of the time during which icing is forecast (including ice accumulation on unprotected surfaces, and the fuel used by engine and wing anti-ice during this period);
- (2) fuel for engine anti-ice, and if appropriate wing anti-ice for the entire time during which icing is forecast.

Note: Unless a reliable icing forecast is available, icing may be presumed to occur when the total air temperature (TAT) at the approved one-engine-inoperative cruise speed is less than +10°C, or if the outside air temperature is between 0°C and -20°C with a relative humidity (RH) of 55 % or greater.

The operator should have a programme established to monitor aeroplane in-service deterioration in cruise fuel burn performance and including in the fuel supply calculations sufficient fuel to compensate for any such deterioration. If there is no data available for such a

programme, the fuel supply should be increased by 5 % to account for deterioration in cruise fuel burn performance.

## **5. ALTERNATE AERODROMES**

To conduct an ETOPS flight, the ETOPS en-route alternate aerodromes should meet the weather requirements of planning minima for an ETOPS en-route alternate aerodrome contained in the applicable operational requirements. ETOPS planning minima apply until dispatch. The planned en-route alternates for using in the event of propulsion system failure or aeroplane system failure(s) which require a diversion should be identified and listed in the cockpit documentation (e.g. computerised flight plan) for all cases where the planned route to be flown contains an ETOPS point

See also [Appendix 5](#) to this AMC 'ETOPS En-route Alternate Aerodromes'.

## **6. IN-FLIGHT RE-PLANNING AND POST-DISPATCH WEATHER MINIMA**

An aeroplane whether or not dispatched as an ETOPS flight may not re-route post dispatch without meeting the applicable operational requirements and without satisfying by a procedure that dispatch criteria have been met. The operator should have a system in place to facilitate such re-routes.

Post-dispatch, weather conditions at the ETOPS en-route alternates should be equal to or better than the normal landing minima for the available instrument approach.

## **7. DELAYED DISPATCH**

If the dispatch of a flight is delayed by more than one hour, pilots and/or operations personnel should monitor weather forecasts and airport status at the nominated en-route alternates to ensure that they stay within the specified planning minima requirements until dispatch.

## **8. DIVERSION DECISION-MAKING**

Operators shall establish procedures for flight crew, outlining the criteria that indicate when a diversion or change of routing is recommended whilst conducting an ETOPS flight. For an ETOPS flight, in the event of the shutdown of an engine, these procedures should include the shutdown of an engine, fly to and land at the nearest aerodrome appropriate for landing.

Factors to be considered when deciding upon the appropriate course of action and suitability of an aerodrome for diversion may include but are not limited to:

- a. Aircraft configuration/weight/systems status;
- b. Wind and weather conditions en route at the diversion altitude;
- c. Minimum altitudes en route to the diversion aerodrome;
- d. Fuel required for the diversion;
- e. Aerodrome condition, terrain, weather and wind;
- f. Runways available and runway surface condition;
- g. Approach aids and lighting;



- h. RFFS\* capability at the diversion aerodrome;
- i. Facilities for aircraft occupants - disembarkation & shelter;
- j. Medical facilities;
- k. Pilot's familiarity with the aerodrome;
- l. Information about the aerodrome available to the flight crew.

Contingency procedures should not be interpreted in any way that prejudices the final authority and responsibility of the pilot-in-command for the safe operation of the aeroplane.

Note: For an ETOPS en-route alternate aerodrome, a published RFFS category equivalent to ICAO category 4, available at 30 minutes' notice, is acceptable.

## **9. IN-FLIGHT MONITORING**

During the flight, the flight crew should remain informed of any significant changes in conditions at designated ETOPS en-route alternate aerodromes. Prior to the ETOPS Entry Point, the forecast weather, established aeroplane status, fuel remaining, and where possible field conditions and aerodrome services and facilities at designated ETOPS en-route alternates are to be evaluated. If any conditions are identified which could preclude safe approach and landing on a designated en-route alternate aerodrome, then the flight crew should take appropriate action, such as re-routing as necessary, to remain within the operator's approved diversion time of an en-route alternate aerodrome with forecast weather to be at or above landing minima. In the event this is not possible, the next nearest en-route alternate aerodrome should be selected provided the diversion time does not exceed the maximum approved diversion time. This does not override the pilot's-in-command authority to select the safest course of action.

## **10. AEROPLANE PERFORMANCE DATA**

The operator should ensure that the Operations Manual contains sufficient data to support the critical fuel reserve and area of operations calculation.

The following data should be based on the information provided by the (S)TC holder. The requirements for one-engine-inoperative performance en-route can be found in the applicable operational requirements.

Detailed one-engine-inoperative performance data including fuel flow for standard and non-standard atmospheric conditions and as a function of airspeed and power setting, where appropriate, covering:

- a. drift down (includes net performance);
- b. cruise altitude coverage including 10 000 feet;
- c. holding;
- d. altitude capability (includes net performance);
- e. missed approach.

Detailed all-engine-operating performance data, including nominal fuel flow data, for standard and non-standard atmospheric conditions and as a function of airspeed and power setting, where appropriate, covering:

- a. cruise (altitude coverage including 10 000 feet); and
- b. holding.

It should also contain details of any other conditions relevant to extended-range operations which can cause significant deterioration of performance, such as ice accumulation on the unprotected surfaces of the aeroplane, ram air turbine (RAT) deployment, thrust reverser deployment, etc.

The altitudes, airspeeds, thrust settings, and fuel flow used in establishing the ETOPS area of operations for each airframe/engine combination should be used in showing the corresponding terrain and obstruction clearances in accordance with the applicable operational requirements.

## **11. OPERATIONAL FLIGHT PLAN**

The type of operation (i.e. ETOPS, including the diversion time used to establish the plan) should be listed on the operational flight plan as required by the applicable operational requirements.

## **Appendix 5 to AMC 20-6B – ETOPS en-route alternate aerodromes**

---

### **1. SELECTION OF EN-ROUTE ALTERNATE AERODROMES**

For an aerodrome to be nominated as an ETOPS en-route alternate for the purpose of this AMC, it should be anticipated that at the expected times of possible use it is an adequate ETOPS aerodrome that meets the weather and field conditions defined in the paragraph below titled 'Dispatch minima – en-route alternate aerodromes' or the applicable operational requirements.

To list an aerodrome as an ETOPS en-route alternate, the following criteria should be met:

- a. The landing distances required as specified in the AFM for the altitude of the aerodrome, for the runway expected to be used, taking into account wind conditions, runway surface conditions, and aeroplane handling characteristics, permit the aeroplane to be stopped within the landing distance available as declared by the aerodrome authorities and computed in accordance with the applicable operational requirements.
- b. The aerodrome services and facilities are adequate to permit an instrument approach procedure to the runway expected to be used while complying with the applicable aerodrome operating minima.
- c. The latest available forecast weather conditions for a period commencing at the earliest potential time of landing and ending 1 hour after the latest nominated time of use of that aerodrome, equals or exceeds the authorised weather minima for en-route alternate aerodromes as provided for by the increments listed in Table 1 of this Appendix. In addition, for the same period, the forecast crosswind component plus any gusts should be within operating limits and within the operator's maximum crosswind limitations taking into account the runway condition (dry, wet or contaminated) plus any reduced visibility limits.
- d. In addition, the operator's programme should provide flight crews with information on adequate aerodromes appropriate to the route to be flown which are not forecast to meet en-route alternate weather minima. Aerodrome facility information and other appropriate planning data concerning these aerodromes should be provided to flight crews for use when executing a diversion.

### **2. DISPATCH MINIMA – EN-ROUTE ALTERNATE AERODROMES**

An aerodrome may be nominated as an ETOPS en-route alternate for flight planning and release purposes if the available forecast weather conditions for a period commencing at the earliest potential time of landing and ending 1 hour after the latest nominated time of use of that aerodrome, equal or exceed the criteria required by Table 1 below.

Table 1. Planning Minima

Approach Facility	Ceiling	Visibility
Precision approach	Authorised DH/DA plus an increment of 200 ft	Authorised visibility plus an increment of 800 metres
Non-precision approach or circling approach	Authorised MDH/MDA plus an increment of 400 ft	Authorised visibility plus an increment of 1 500 metres

The above criteria for precision approaches are only to be applied to Category 1 approaches.

When determining the usability of an instrument approach (IAP), forecast wind plus any gusts should be within operating limits, and within the operator’s maximum crosswind limitations taking into account the runway condition (dry, wet or contaminated) plus any reduced visibility limits. Conditional forecast elements need not be considered, except that a PROB 40 or TEMPO condition below the lowest applicable operating minima should be taken into account.

When dispatching under the provisions of the MEL, those MEL limitations affecting instrument approach minima should be considered in determining ETOPS alternate minima.

### 3. EN-ROUTE ALTERNATE AERODROME PLANNING MINIMA - ADVANCED LANDING SYSTEMS

The increments required by Table 1 are normally not applicable to Category II or III minima unless specifically approved by the CAA.

Approval will be based on the following criteria:

- a. Aircraft is capable of engine-inoperative Cat II/III landing; and
- b. Operator is approved for normal Cat II/III operations.

The CAA may require additional data (such as safety assessment or in-service records) to support such an application. For example, it should be shown that the specific aeroplane type can maintain the capability to safely conduct and complete the Category II/III approach and landing, in accordance with EASA CS-AWO, having encountered failure conditions in the airframe and/or propulsion systems associated with an inoperative engine that would result in the need for a diversion to the en-route alternate aerodrome.

Systems to support one-engine inoperative Category II or III capability should be serviceable if required to take advantage of Category II or III landing minima at the planning stage.

## **Appendix 6 to AMC 20-6B – ETOPS training programme**

---

The operator's ETOPS training programme should provide initial and recurrent training for flight crew as follows:

### **1. INTRODUCTION TO ETOPS REGULATIONS**

- a. Brief overview of the history of ETOPS;
- b. ETOPS regulations;
- c. Definitions;
- d. Approved one-engine-inoperative cruise speed;
- e. ETOPS type design approval – a brief synopsis;
- f. Maximum approved diversion times and time-limited systems capability;
- g. Operator's approved diversion Time;
- h. Routes and aerodromes intended to be used in the ETOPS area of operations;
- i. ETOPS operations approval;
- j. ETOPS area and routes;
- k. ETOPS en-route alternates aerodromes including all available let-down aids;
- l. Navigation systems accuracy, limitations and operating procedures;
- m. Meteorological facilities and availability of information;
- n. In-flight monitoring procedures;
- o. Computerised flight plan;
- p. Orientation charts, including low level planning charts and flight progress charts usage (including position plotting);
- q. Equal time point;
- r. Critical fuel.

### **2. NORMAL OPERATIONS**

- a. Flight planning and Dispatch
  - (1) ETOPS fuel requirements
  - (2) Route alternate selection - weather minima
  - (3) Minimum equipment list – ETOPS specific
  - (4) ETOPS service check and Tech log
  - (5) Pre-flight FMS set-up
- b. Flight performance progress monitoring
  - (1) Flight management, navigation and communication systems
  - (2) Aeroplane system monitoring

- (3) Weather monitoring
- (4) In-flight fuel management – to include independent cross checking of fuel quantity

### **3. ABNORMAL AND CONTINGENCY PROCEDURES**

- a. Diversion Procedures and Diversion ‘decision-making’.

Initial and recurrent training to prepare flight crews to evaluate potential significant system failures. The goal of this training should be to establish crew competency in dealing with the most probable contingencies. The discussion should include the factors that may require medical, passenger-related or non-technical diversions.

- b. Navigation and communication systems, including appropriate flight management devices in degraded modes.
- c. Fuel management with degraded systems.
- d. Initial and recurrent training which emphasises abnormal and emergency procedures to be followed in the event of foreseeable failures for each area of operation, including:
  - (1) Procedures for single and multiple failures in flight affecting ETOPS sector entry and diversion decisions. If standby sources of electrical power significantly degrade the cockpit instrumentation to the pilots, then training for approaches with the standby generator as the sole power source should be conducted during initial and recurrent training.
  - (2) Operational restrictions associated with these system failures including any applicable MEL considerations.

### **4. ETOPS LINE FLYING UNDER SUPERVISION (LFUS)**

During the introduction into service of a new ETOPS type, or conversion of pilots not previously ETOPS qualified where ETOPS approval is sought, a minimum of two ETOPS sectors should be completed including an ETOPS line check.

ETOPS subjects should also be included in annual refresher training as part of the normal process.

### **5. FLIGHT OPERATIONS PERSONNEL OTHER THAN FLIGHT CREW**

The operator’s training programme in respect to ETOPS should provide training where applicable for operations personnel other than flight crew (e.g. dispatchers), in addition to refresher training in the following areas:

- a. ETOPS regulations/operations approval
- b. Aeroplane performance/diversion procedures

- c. Area of operation
- d. Fuel requirements
- e. Dispatch considerations MEL, CDL, weather minima, and alternate airports
- f. Documentation

## **Appendix 7 to AMC 20-6B – Typical ETOPS operations manual supplement**

---

The ETOPS Operations Manual can take the form of a supplement or a dedicated manual, and it could be divided under these headings as follows:

### **PART A. GENERAL/BASIC**

- a. Introduction
  - (1) Brief description of ETOPS
  - (2) Definitions
- b. Operations approval
  - (1) Criteria
  - (2) Assessment
  - (3) Approved diversion time
- c. Training and checking
- d. Operating procedures
- e. ETOPS operational procedures
- f. ETOPS flight preparation and planning
  - (1) Aeroplane serviceability
  - (2) ETOPS orientation charts
  - (3) ETOPS alternate aerodrome selection
  - (4) En-route alternate weather requirements for planning
  - (5) ETOPS computerised Flight Plans
- g. Flight crew procedures
  - (1) Dispatch
  - (2) Re-routing or diversion decision-making
  - (3) ETOPS verification (following maintenance) flight requirements
  - (4) En-route Monitoring

### **PART B. AEROPLANE OPERATING MATTERS**

This part should include type-related instructions and procedures needed for ETOPS.

- a. Specific type-related ETOPS operations
  - (1) ETOPS specific limitations
  - (2) Types of ETOPS operations that are approved
  - (3) Placards and limitations
  - (4) OEI speed(s)



- (5) Identification of ETOPS aeroplanes
- b. Dispatch and flight planning, plus in-flight planning
  - (1) Type-specific flight planning instructions for use during dispatch and post dispatch
  - (2) Procedures for engine(s)-out operations, ETOPS (particularly the one-engine-inoperative cruise speed and maximum distance to an adequate aerodrome should be included)
- c. ETOPS fuel planning
- d. Critical fuel scenario
- e. MEL/CDL considerations
- f. ETOPS specific minimum equipment list items
- g. Aeroplane systems
  - (1) Aeroplane performance data including speed schedules and power settings
  - (2) Aeroplane technical differences, special equipment (e.g. satellite communications) and modifications required for ETOPS

### **PART C. ROUTE AND AERODROME INSTRUCTIONS**

This part should comprise all instructions and information needed for the area of operation, to include the following as necessary:

- a. ETOPS area and routes, approved area(s) of operations and associated limiting distances
- b. ETOPS en-route alternates
- c. Meteorological facilities and availability of information for in-flight monitoring
- d. Specific ETOPS computerised flight plan information
- e. Low altitude cruise information, minimum diversion altitude, minimum oxygen requirements and any additional oxygen required on specified routes if MSA restrictions apply
- f. Aerodrome characteristics (landing distance available, take off distance available) and weather minima for aerodromes that are designated as possible alternates

### **PART D. TRAINING**

This part should contain the route and aerodrome training for ETOPS operations. This training should have 12 months of validity or as required by the applicable operational requirements. Flight crew training records for ETOPS should be retained for 3 years or as required by the applicable requirements.

The operator's training programme in respect to ETOPS should include initial and recurrent training/checking as specified in this AMC.

## **Appendix 8 to AMC 20-6B – Continuing airworthiness considerations**

---

### **1. APPLICABILITY**

The requirements of this Appendix apply to the continuing airworthiness management organisations (CAMO) managing the aircraft for which an ETOPS operational approval is sought, and they are to be complied with in addition to the applicable continuing airworthiness requirements of MCAR-CAMO and MCAR-M. They specifically affect:

- a. Occurrence reporting;
- b. Aircraft maintenance programme and reliability programme;
- c. Continuing airworthiness management exposition;
- d. Competence of continuing airworthiness and maintenance personnel.

### **2. OCURRENCE REPORTING**

In addition to the items generally required to be reported in accordance with MCAR-13B, the following items concerning ETOPS should be included:

- a. in-flight shutdowns;
- b. diversion or turn-back;
- c. un-commanded power changes or surges;
- d. inability to control the engine or obtain desired power; and
- e. failures or malfunctions of ETOPS significant systems having a detrimental effect to ETOPS flight.

Note: Status messages, transient failures, intermittent indication of failure, messages tested satisfactorily on ground not duplicating the failure should only be reported after an assessment by the operator that an unacceptable trend has occurred on the system.

The report should identify as applicable the following:

- a. aircraft identification;
- b. engine, propeller or APU identification (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.

The CAA and the (S)TC holder should be notified within 72 hours of events that are reportable through this programme.

### **3. MAINTENANCE PROGRAMME AND RELIABILITY PROGRAMME**

The quality of maintenance and reliability programmes can have an appreciable effect on the reliability of the propulsion system and the ETOPS significant systems. The CAA will assess the proposed maintenance and reliability programme's ability to maintain an acceptable level of safety for the propulsion system and the ETOPS significant systems of the particular airframe/engine combination.

#### **3.1 MAINTENANCE PROGRAMME**

The maintenance programme of an aircraft for which ETOPS operational approval is sought, should contain the standards, guidance and instructions necessary to support the intended operation. The specific ETOPS maintenance tasks identified by the (S)TC holder in the configuration, maintenance and procedures document (CMP) or equivalent should be included in the maintenance programme and identified as ETOPS tasks.

An ETOPS maintenance task could be an ETOPS specific task or/and a maintenance task affecting an ETOPS significant system. An ETOPS specific task could be either an existing task with a different interval for ETOPS, a task unique to ETOPS operations, or a task mandated by the CMP further to the in-service experience review (note that in the case ETOPS is considered as the baseline in the development of a maintenance program, no 'ETOPS specific' task may be identified in the MRB).

The maintenance programme should include tasks to maintain the integrity of cargo compartment and pressurisation features, including baggage hold liners, door seals and drain valve condition. Processes should be implemented to monitor the effectiveness of the maintenance programme in this regard.

##### **3.1.1 PRE-DEPARTURE SERVICE CHECK**

An ETOPS service check should be developed to verify the status of the aeroplane and the ETOPS significant systems. This check should be accomplished by an authorised and trained person prior to an ETOPS flight. Such a person may be a member of the flight crew.

#### **3.2 RELIABILITY PROGRAMME:**

##### **3.2.1 GENERAL**

The reliability programme of an ETOPS operated aircraft should be designed with early identification and prevention of failures or malfunctions of ETOPS significant systems as the primary goal. Therefore the reliability programme should include assessment of ETOPS significant systems performance during scheduled inspection/testing, to detect system failure trends in order to implement appropriate corrective action such as scheduled task adjustment.

The reliability programme should be event-orientated and incorporate:

- a. reporting procedures in accordance with Section 2: Occurrence reporting

- b. operator's assessment of propulsion systems reliability
- c. APU in-flight start programme
- d. Oil consumption programme
- e. Engine condition monitoring programme
- f. Verification programme

### 3.2.2 ASSESSMENT OF PROPULSION SYSTEMS RELIABILITY

- a. The operator's assessment of propulsion systems reliability for the ETOPS fleet should be made available to the CAA (with the supporting data) on at least a monthly basis, to ensure that the approved maintenance programme continues to maintain a level of reliability necessary for ETOPS operations as established in the type design.
- b. The assessment should include, as a minimum, engine hours flown in the period, in-flight shutdown rate for all causes and engine removal rate, both on a 12-month moving average basis. Where the combined ETOPS fleet is part of a larger fleet of the same aircraft/engine combination, data from the total fleet will be acceptable.
- c. Any adverse sustained trend to propulsion systems would require an immediate evaluation to be accomplished by the operator in consultation with the CAA. The evaluation may result in corrective action or operational restrictions being applied.
- d. A high engine in-flight shutdown rate for a small fleet may be due to the limited number of engine operating hours and may not be indicative for an unacceptable trend. The underlying causes for such an increase in the rate will have to be reviewed on a case-by-case basis in order to identify the root cause of events so that the appropriate corrective action is implemented.
- e. If an operator has an unacceptable engine in-flight shutdown rate caused by maintenance or operational practices, then the appropriated corrective actions should be taken.

### 3.2.3 APU IN-FLIGHT START PROGRAMME

- a. Where an APU is required for ETOPS and the aircraft is not operated with this APU running prior to the ETOPS entry point, the operator should initially implement a cold soak in-flight starting programme to verify that start reliability at cruise altitude is above 95%.

Once the APU in-flight start reliability is proven, the APU in-flight start monitoring programme may be alleviated. The APU in-flight start monitoring programme should be acceptable to the CAA.

- b. The Maintenance procedures should include the verification of in-flight start reliability following maintenance of the APU and APU components, as defined by the OEM, where start reliability at altitude may have been affected.

#### 3.2.4 OIL CONSUMPTION MONITORING PROGRAMME

The oil consumption monitoring programme should reflect the (S)TC holder's recommendations and track oil consumption trends. The monitoring programme must be continuous and include all oil added at the departure station.

If oil analysis is recommended to the type of engine installed, it should be included in the programme.

If the APU is required for ETOPS dispatch, an APU oil consumption monitoring programme should be added to the oil consumption monitoring programme.

#### 3.2.5 ENGINE CONDITION MONITORING PROGRAMME

The engine condition monitoring programme should ensure that a one-engine-inoperative diversion may be conducted without exceeding approved engine limits (e.g. rotor speeds, exhaust gas temperature) at all approved power levels and expected environmental conditions. Engine limits established in the monitoring programme should account for the effects of additional engine loading demands (e.g. anti-icing, electrical, etc.), which may be required during the one-engine-inoperative flight phase associated with the diversion.

The engine condition monitoring programme should describe the parameters to be monitored, method of data collection and corrective action process. The programme should reflect manufacturer's instructions and industry practice. This monitoring will be used to detect deterioration at an early stage to allow for corrective action before safe operation of the aircraft is affected.

#### 3.2.6 VERIFICATION PROGRAMME

The operator should develop a verification programme to ensure that the corrective action required to be accomplished following an engine shutdown, any ETOPS significant system failure or adverse trends or any event which require a verification flight or other verification action are established. A clear description of who must initiate verification actions and the section or group responsible for the determination of what action is necessary should be identified in this verification programme. ETOPS significant systems or conditions requiring verification actions should be described in the continuing airworthiness management exposition (CAME). The CAMO may request the support of the (S)TC holder to identify when these actions are necessary. Nevertheless, the CAMO may propose alternative operational procedures to ensure

system integrity. This may be based on system monitoring in the period of flight prior to entering an ETOPS area.

#### **4. CONTINUING AIRWORTHINESS MANAGEMENT EXPOSITION**

The CAMO should develop appropriate procedures to be used by all personnel involved in the continuing airworthiness and maintenance of the aircraft, including supportive training programmes, duties, and responsibilities.

The CAMO should specify the procedures necessary to ensure the continuing airworthiness of the aircraft particularly related to ETOPS operations. It should address the following subjects as applicable:

- a. General description of ETOPS procedures
- b. ETOPS maintenance programme development and amendment
- c. ETOPS reliability programme procedures
  - (1) Engine/APU oil consumption monitoring
  - (2) Engine/APU Oil analysis
  - (3) Engine conditioning monitoring
  - (4) APU in-flight start programme
  - (5) Verification programme after maintenance
  - (6) Failures, malfunctions and defect reporting
  - (7) Propulsion system monitoring/reporting
  - (8) ETOPS significant systems reliability
- d. Parts and configuration control programme
- e. Maintenance procedures that include procedures to preclude identical errors being applied to multiple similar elements in any ETOPS significant system
- f. Interface procedures with the ETOPS maintenance contractor, including the operator ETOPS procedures that involve the maintenance organisation and the specific requirements of the contract
- g. Procedures to establish and control the competence of the personnel involved in the continuing airworthiness and maintenance of the ETOPS fleet.

#### **5. COMPETENCE OF CONTINUING AIRWORTHINESS AND MAINTENANCE PERSONNEL**

The CAMO should ensure that the personnel involved in the continuing airworthiness management of the aircraft have knowledge of the ETOPS procedures of the operator.

The CAMO should ensure that maintenance personnel that are involved in ETOPS maintenance tasks:

- a. Have completed an ETOPS training programme reflecting the relevant ETOPS procedures of the operator, and,
- b. Have satisfactorily performed ETOPS tasks under supervision, within the framework of the MCAR-145 approved procedures for Personnel Authorisation.

5.1. PROPOSED TRAINING PROGRAMME FOR PERSONNEL INVOLVED IN THE CONTINUING AIRWORTHINESS AND MAINTENANCE OF THE ETOPS FLEET

The operator's ETOPS training programme should provide initial and recurrent training for as follows:

1. INTRODUCTION TO ETOPS REGULATIONS
  - a. Contents of AMC 20-6
  - b. ETOPS type design approval – a brief synopsis
2. ETOPS OPERATIONS APPROVAL
  - a. Maximum approved diversion times and time-limited systems capability
  - b. Operator's approved diversion time
  - c. ETOPS area and routes
  - d. ETOPS MEL
3. ETOPS CONTINUING AIRWORTHINESS CONSIDERATIONS
  - a. ETOPS significant systems
  - b. CMP and ETOPS aircraft maintenance programme
  - c. ETOPS pre-departure service check
  - d. ETOPS reliability programme procedures
    - (1) Engine/ APU oil consumption monitoring
    - (2) Engine/APU oil analysis
    - (3) Engine conditioning monitoring
    - (4) APU in-flight start programme
    - (5) Verification programme after maintenance
    - (6) Failures, malfunctions and defect reporting
    - (7) Propulsion system monitoring/reporting
    - (8) ETOPS significant systems reliability
  - e. Parts and configuration control programme
  - f. CAMO additional procedures for ETOPS
  - g. Interface procedures between MCAR-145 organisation and CAMO

## AMC 20-20B

### AMC 20-20B Continuing structural integrity programme

---

#### 1. PURPOSE

- (a) This acceptable means of compliance (AMC) provides guidance to maintenance organisations and operators for developing continuing structural integrity programmes to ensure safe operation of ageing aircraft throughout their operational lives.

This AMC is primarily aimed at large aeroplanes; however, this material is also applicable to other aircraft types for operators wishing to develop robust continuing structural integrity programmes.

#### 2. RELATED REGULATIONS AND DOCUMENTS

- (a) Regulations:

Point 21.A.07 Instructions for continued airworthiness

Point 21.A.433 Repair design

Point M.A.302 Maintenance programme

#### 3. BACKGROUND

Service experience has shown there is a need to have continually updated knowledge on the structural integrity of aircraft, especially as they become older, to ensure they continue to meet the level of safety intended by the certification requirements. The continued structural integrity of aircraft is of concern because factors such as fatigue cracking and corrosion are time-dependent, and our knowledge about them can best be assessed based on real-time operational experience and the use of the most modern tools of analysis and testing.

In April 1988, a high-cycle transport aeroplane en-route from Hilo to Honolulu, Hawaii, suffered major structural damage to its pressurised fuselage during flight. This accident was attributed in part to the age of the aeroplane involved. The economic benefit of operating certain older technology aeroplanes resulted in the operation of many such aeroplanes beyond their previously expected retirement age. Because of the problems revealed by the accident in Hawaii and the continued operation of older aircraft, both the national aviation authorities and industry generally agreed that increased attention needed to be focused on the ageing fleet and on maintaining its continued operational safety.

In June 1988, the FAA sponsored a conference on ageing aircraft. As a result of that conference, an ageing aircraft task force was established in August 1988 as a sub-group of the FAA's Research, Engineering, and Development Advisory Committee, representing the interests of the aircraft operators, aircraft manufacturers, regulatory authorities, and other aviation representatives. The task force, then



known as the Airworthiness Assurance Task Force (AATF), set forth five major elements of a programme for keeping the ageing fleet safe. For each aeroplane model in the ageing transport fleet, these elements consisted of the following:

- (a) Select service bulletins describing modifications and inspections necessary to maintain structural integrity;
- (b) Develop inspection and prevention programmes to address corrosion;
- (c) Develop generic structural maintenance programme guidelines for ageing aeroplanes;
- (d) Review and update the supplemental structural inspection documents (SSIDs) which describe inspection programmes to detect fatigue cracking; and
- (e) Assess the damage tolerance of structural repairs.

Subsequent to these five major elements being identified, it was recognised that an additional factor in the Aloha accident was widespread fatigue cracking. Regulatory and industry experts agreed that, as the transport aircraft fleet continues to age, eventually widespread fatigue damage (WFD) is inevitable. The subsequent establishment of new regulations led to the current format of MCAR-M for continuing airworthiness, the associated maintenance programme requirements and to the inclusion of ageing aircraft structures programmes in AMC of MCAR-M (M.A.302).

#### 4. DEFINITIONS AND ACRONYMS

- (a) For the purposes of this AMC, the following definitions apply:

- 
- **Baseline structure** refers to the structure that is designed under the type certificate for that aeroplane model (that is, the 'as delivered aeroplane model configuration').
- **Corrosion prevention and control programme (CPCP)** is a document reflecting a systematic approach to prevent and to control corrosion in an aeroplane's primary structure, consisting of basic corrosion tasks, including inspections, areas subject to those tasks, defined corrosion levels and compliance times (implementation thresholds and repeat intervals). A baseline CPCP is established by the type certificate holder, which can be adapted by operators to create a CPCP in their maintenance programme specific to their operations.
- **Damage tolerance (DT)** is the attribute of the structure that permits it to retain its required residual strength without detrimental structural deformation for a period of use after the structure has sustained a given level of fatigue, corrosion, and accidental or discrete source damage.

- **Design approval holder (DAH)** is the holder of any design approval, including type certificate, supplemental type certificate or earlier equivalent, or repair approval.
- **Damage tolerance data** is the combination of DTE documentation and DTI.
- **Damage tolerance evaluation (DTE)** is a process that leads to the determination of the maintenance actions necessary to detect or preclude fatigue cracking that could contribute to a catastrophic failure. When applied to repairs and changes, a DTE includes the evaluation of the repair or change and the fatigue-critical structure affected by the repair or change.
- **Damage tolerance inspection (DTI)** is a documented inspection requirement or other maintenance action developed by holders of design approvals or third parties as a result of a damage tolerance evaluation. A DTI includes the areas to be inspected, the inspection method, the inspection procedures (including the sequential inspection steps and acceptance and rejection criteria), the inspection threshold and any repetitive intervals associated with those inspections. DTIs may also specify maintenance actions such as replacement, repair or modification.
- **Design service goal (DSG)** is the period of time (in flight cycles or flight hours, or both) established at design and/or certification during which the aeroplane structure is expected to be reasonably free from significant cracking.
- **Existing design changes or repairs** are changes and repairs which are to be approved before the date of entry into force of this rule.
- **Fatigue-critical alteration structure (FCAS)** is equivalent to fatigue-critical modified structure.
- **Fatigue-critical baseline structure (FCBS)** is the baseline structure of an aeroplane that is classified by the type certificate holder as a fatigue-critical structure.
- **Fatigue-critical modified structure (FCMS)** means any fatigue-critical structure of an aeroplane introduced or affected by a change to its type design and that is not already listed as part of the fatigue-critical baseline structure.
- **Fatigue-critical structure (FCS)** is a structure of an aeroplane that is susceptible to fatigue cracking that could lead to a catastrophic failure of the aircraft. For the purposes of this AMC, FCS refers to the same class of structure that would need to be assessed for compliance with JAR 25.571 Change 7 or 14CFR § 25.571(a) at Amendment 25-45, or later. The term 'FCS' may refer to fatigue-critical baseline structure, fatigue-critical modified structure, or both.

- **Inspection start point (ISP)** is the point in time when special inspections of the fleet are initiated due to a specific probability of having an MSD/MED condition.
- **Future design changes and repairs** are changes and repairs which are to be approved on or after the date of entry into force of this rule.
- **Limit of validity (LOV) (of the engineering data that supports the structural maintenance programme)** means, in the context of the engineering data that supports the structural maintenance programme, a period of time, stated as a number of total accumulated flight cycles or flight hours or both, during which it is demonstrated that widespread fatigue damage will not occur in the aeroplane.
- **Multiple-element damage (MED)** is a source of widespread fatigue damage characterised by the simultaneous presence of fatigue cracks in similar adjacent structural elements.
- **Multiple-site damage (MSD)** is a source of widespread fatigue damage characterised by the simultaneous presence of fatigue cracks in the same structural element.
- **Primary structure** is structure that carries flight, ground, crash or pressurisation loads.
- **Published repair data** are instructions for accomplishing repairs which are published for general use in structural repair manuals and service bulletins (or equivalent types of documents).
- **Repair assessment guidelines (RAGs)** provide a process to establish damage tolerance inspections for repairs on the fuselage pressure boundary structure.
- **Repair assessment programme (RAP)** is a programme to incorporate damage-tolerance-based inspections for repairs to the fuselage pressure boundary structure (fuselage skin, door skin, and bulkhead webs) into the operator's maintenance and/or inspection programme.
- **Repair evaluation guidelines (REGs)** are established by the type certificate holder and guide operators to establish damage tolerance inspections for repairs that affect fatigue-critical structure to ensure the continued structural integrity of all relevant repairs.
- **Structural modification point (SMP)** is the point in time when a structural area must be modified to preclude WFD.
- **Widespread fatigue damage (WFD)** means the simultaneous presence of cracks at multiple locations in the structure of an aeroplane that are of such size and number that the structure will no longer meet the fail-safe strength or residual strength used for the certification of that structure.

(b) The following list defines the acronyms that are used throughout this AMC:

AAWG	Airworthiness Assurance Working Group
AC	advisory circular
AD	airworthiness directive
ALS	airworthiness limitations section
AMC	acceptable means of compliance
ARAC	Aviation Rulemaking Advisory Committee
BZI	baseline zonal inspection
CAW	continuing airworthiness
CPCP	corrosion prevention and control programme
CS	certification specification
DAH	design approval holder
DSD	discrete source damage
DSG	design service goal
DT	damage tolerance
DTE	damage tolerance evaluation
DTI	damage tolerance inspection
EAAWG	European Ageing Aircraft Working Group
EASA	European Union Aviation Safety Agency
ESG	extended service goal
FAA	Federal Aviation Administration
FAR	Federal Aviation Regulation
FCBS	fatigue-critical baseline structure
FCS	fatigue-critical structure
ICA	instructions for continued airworthiness
ISP	inspection start point
JAA	Joint Aviation Authorities
JAR	joint aviation regulation
LOV	limit of validity
MED	multiple-element damage
MRB	Maintenance Review Board
MSD	multiple-site damage
MTOM	maximum take-off mass
MSG	Maintenance Steering Group
NAA	national aviation authority
NDI	non-destructive inspection
NTSB	National Transportation Safety Board
PSE	principal structural element
RAP	repairs assessment programme
REGs	repair evaluation guidelines
SB	service bulletin
SMP	structural modification point
SRM	structural repair manual
SSID	supplemental structural inspection document

SSIP	supplemental structural inspection programme
STG	structural task group
STCH	supplemental type certificate holder
TCH	type certificate holder
WFD	widespread fatigue damage

**5. (Reserved)**

**9. CORROSION PREVENTION AND CONTROL PROGRAMME**

A corrosion prevention and control programme (CPCP) is a systematic approach to prevent and to control corrosion in the aircraft's primary structure. The objective of a CPCP is to limit the deterioration due to corrosion to the level necessary to maintain airworthiness and, where necessary, to restore the corrosion protection schemes for the structure. A CPCP consists of a basic corrosion inspection task, task areas, defined corrosion levels, and compliance times (implementation thresholds and repeat intervals). The CPCP also includes procedures to notify the CAA and TCH of the findings and data associated with Level 2 and Level 3 corrosion and the actions taken to reduce future findings to Level 1 or better. See [Appendix 4](#) for definitions and further details.

As part of the ICA, the TCH should provide an inspection programme that includes the frequency and extent of the inspections necessary to provide the continued airworthiness of the aircraft. Furthermore, the ICA should include the information needed to apply protective treatments to the structure after inspection. In order for the inspections to be effectively accomplished, the TCH should provide corrosion removal and cleaning procedures and reference allowable limits (e.g. an SRM). The TCH should include all of these corrosion-related activities in a manual referred to as the baseline CPCP. This baseline CPCP documentation is intended to form a basis for operators to derive a systematic and comprehensive CPCP for inclusion in the operator's maintenance programme. For operators and owners subject to point 26.370 of EASA Part 26, the operator's CPCP must take into account the TCH's baseline CPCP. The TCH is responsible for monitoring the effectiveness of the baseline CPCP and, if necessary, for recommending changes based on the operator's reports of findings. In line with the MCAR-M requirements, when the TCH publishes revisions to their baseline CPCP, these should be reviewed and the operator's programme adjusted as necessary in order to limit corrosion to Level 1 or better.

The operator should ensure that the CPCP is comprehensive in that it addresses all corrosion likely to affect primary structure, and is systematic in that:

- (a) it provides step-by-step procedures that are applied on a regular basis to each identified task area or zone, and
- (b) these procedures are adjusted when they result in evidence that corrosion is not being limited to an established acceptable level (Level 1 or better).

*Note:* For an aeroplane with an ALS, in addition to providing a suitable baseline CPCP in the ICA, it is appropriate for the TCH to place an entry in the ALS stating that all

corrosion should be limited to Level 1 or better. (This practice is also described in ATA MSG-3.)

**Appendix 1 to AMC 20-20B (Reserved)**

---

**Appendix 2 to AMC 20-20B (Reserved)**

---

### **Appendix 3 to AMC 20-20B Guidelines for establishing instructions for continued airworthiness of structural repairs and modifications**

---

#### **6. OPERATOR TASKS — REPAIRS, MODIFICATIONS AND REPAIRS TO MODIFICATIONS IN SUPPORT OF COMPLIANCE WITH POINT 26.370 OF EASA PART-26.**

This paragraph provides guidance to operators for developing a means for addressing the adverse effects that repairs and modifications may have on FCS. The guidance supports operators that need to comply with point 26.370 of Part-26, and explains how operators can develop an implementation plan to obtain and implement all the applicable DT data for modifications and repairs when using EASA CS 26.370 as a means of compliance. The plan will contain processes and timelines for operators to use, for obtaining and incorporating into their maintenance programme, DTIs that address the adverse effects of repairs and modifications.

Operators will need to determine how they will obtain the information necessary to develop the plan by considering the following conditions:

- (a) The operator processes ensure that DT data for repairs and modifications affecting FCBS have been developed and all the applicable DTIs have been incorporated into the operator's maintenance programme. If an operator is able to demonstrate that these processes have been in place and followed throughout the operational life of the aircraft for all repairs and modifications affecting FCBS, then no further action is required for existing repairs and modifications
- (b) The TCH or STCH or other DAH exists and will make the DTIs available to the operator automatically or upon request .
- (c) DTIs already exist and are available.
- (d) DTIs are not available from the TCH or STCH or other DAH;
- (e) DTIs are not available for modifications developed by organisations other than TCH or STC holders (e.g. major changes approved under FAA Form 337, but that were approved before 14 CFR Part-26 became applicable).

Figure A3-1 below outlines an overview of developing a means of compliance for modifications to be addressed by STCHs/TCHs and operators in order to comply with points 26.306 to 26.309, 26.332 to 26.334 and 26.370 of Part-26.



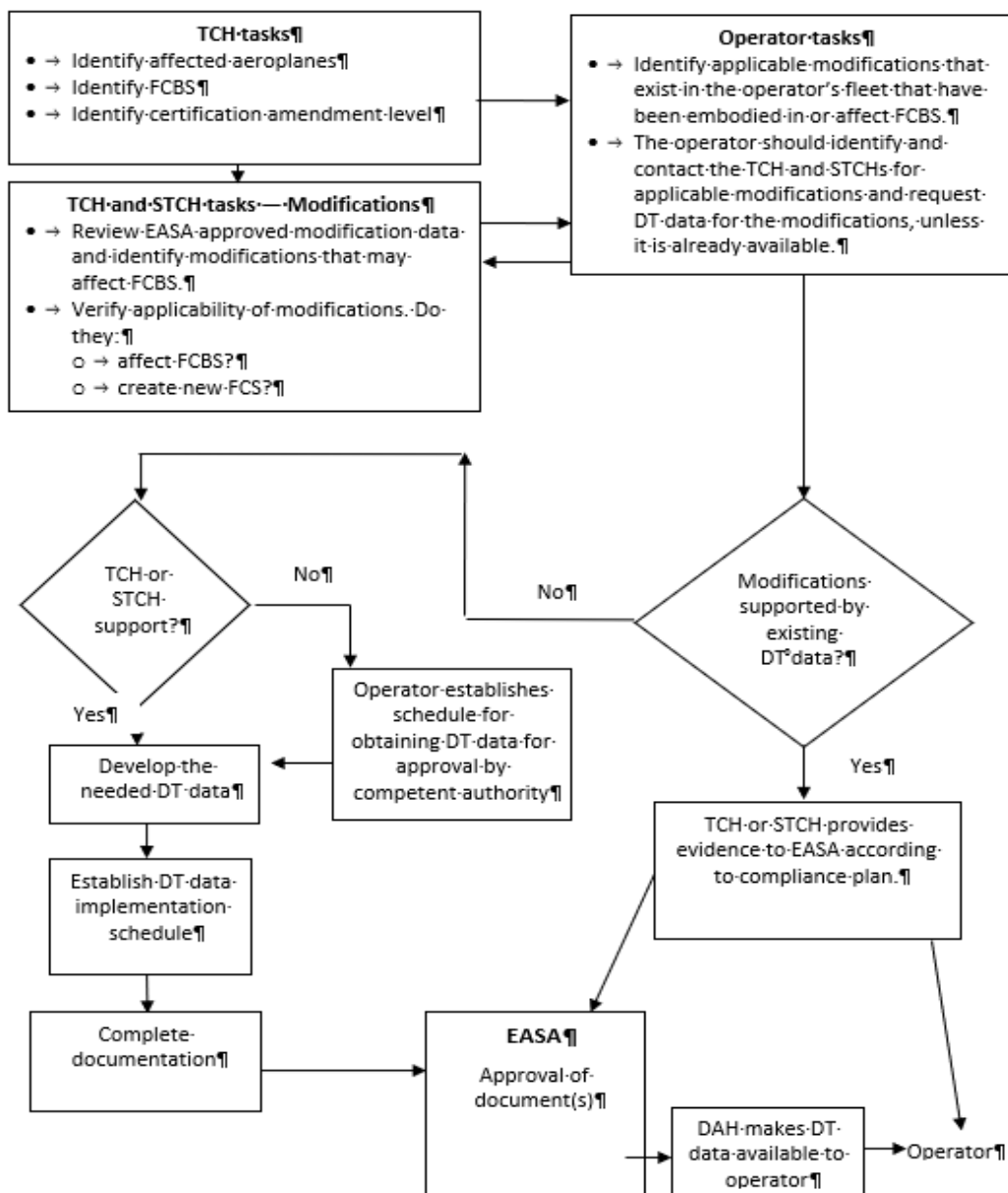


Figure A3-1: Developing a means of compliance for modifications

### 6.1. Contents of the maintenance programme

- (a) The operator’s maintenance programme should contain or refer to an implementation plan that ensures that:
  - (1) all new repairs and modifications that affect FCBS will have DT data and DTI or other procedures implemented;
  - (2) all existing repairs and modifications to FCBS have been or will be evaluated for damage tolerance and have DTI or other procedures

implemented. In the context of this implementation plan, there should be a process that:

- (i) reviews operator processes to determine if DT data for repairs and modifications affecting FCBS have been developed and incorporated into the operator’s maintenance programme for the operational life of the aircraft. If an operator is able to demonstrate that these processes ensure that DT data is developed for all repairs and modifications affecting FCBS, then no further action is required for existing repairs and modifications.
  - (ii) identifies or surveys existing repairs (using guidance such as FAA AC 120-73) and modifications that affect FCBS and obtain and implement DTI for those repairs and modifications. This should include an implementation schedule that provides timing for incorporation of the DT data into the operator’s maintenance programme, within the time frame given in the applicable TCH or STCH’s approved documentation.
- (b) Figure A3-2 below outlines one possible means that an operator can use to develop an implementation plan for aircraft in their fleet.

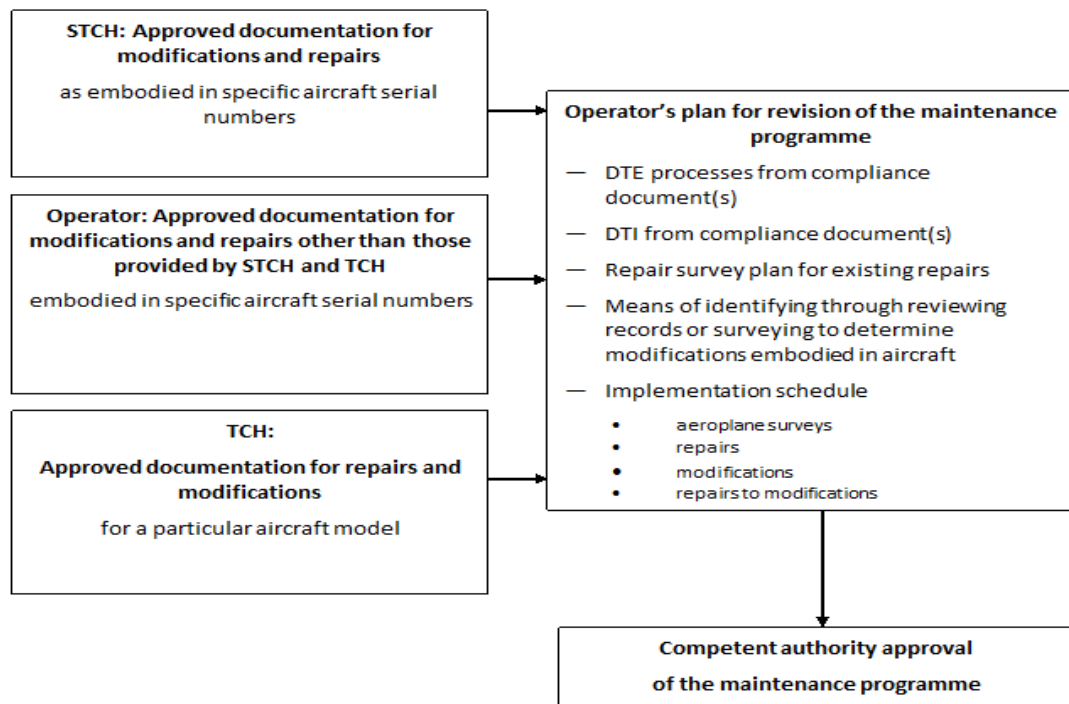


Figure A3-2: Operator’s maintenance programme approval process

### 6.1.1. Implementation plan for repairs

Except as described in EASA CS 26.370, the maintenance programme should include a repair survey schedule to identify repairs that may need DT data developed. The TCH's REGs may be used as a basis for this plan.

### 6.1.2. Implementation plan and actions for modifications

- (a) To show compliance with EASA CS 26.370, operators are first requested to develop a list of modifications affecting FCBS through a review of the aircraft records. The operator will need to show to the CAA that the aircraft records are a reliable means for identifying modifications that affect FCBS. The aircraft records, in conjunction with data provided by the DAH, may also be sufficient to help identify whether DTI exists for all modifications. However, for some older aircraft, a review of records alone may not always be adequate to identify all the modifications that have an adverse effect on FCBS, or be sufficient to establish whether a DTE has been accomplished and DTI is complete, without requesting such information from the DAH. Physical inspection of the aircraft may help establish the scope of the modification if it is unclear from the records. Finally, the aircraft survey for repairs may also identify modifications affecting FCS, which should then be evaluated and DTI obtained as necessary in accordance with EASA CS 26.370(h).
- (b) To support identification of modifications that need to be addressed, operators should — concurrently with the TCH and STCHs' tasks — identify the TCH or STC or other approval holder-developed modifications that exist in their aircraft fleets. To support compliance with point 26.370 of Part-26 as envisaged in CS 26.370, operators should perform the following tasks:
- (1) From the review of records, compile a listing of all TCH and STCH-developed modifications that are currently installed on their fleet.
  - (2) Delete from the listing those modifications that do not affect FCBS. Documents from the TCH may be used to identify the FCBS.  
  
*Note:* In order to ensure timely compliance with point 26.370 of Part-26, operators should begin developing the list of modifications that affect FCBS, for each affected aircraft in the fleet, as soon as the TCHs make their FCBS listing available.
  - (3) The modifications that affect FCBS must be reviewed to determine whether:
    - (i) DT data already exists in the maintenance programme, or is available and is complete; or

- (ii) DT data needs to be developed.
- (4) For DT data that is complete, the operator should incorporate it into the maintenance programme and implement it according to the schedule provided in 6.1.3 or as otherwise agreed by the CAA.
- (5) For DT data that is not available or is incomplete 30 months after the date of applicability of point 26.370 of Part-26, the operator should ensure that the plan developed according to EASA CS 26.370 will address each affected modification.
- (6) Where DT data is not available or is incomplete, the operator should notify both the STCH or a third party that DT data for the modification is required.
- (7) Establish whether the STCH or a third party will provide the data.

Whatever the approval date of the change, the operator is responsible for obtaining the DTI from the approval holder once it becomes available. It is therefore recommended that the operator contacts the approval holder or a third party as soon as possible after identifying a modification that affects FCBS to establish when the DTI will become available.

- (8) For those modifications where the DTI will not be incorporated into the maintenance programme within 36 months from the date of applicability of point 26.370(a)(ii) of EASA Part 26, the operator's DT data implementation plan should contain the following information:
  - (i) a description of the modification;
  - (ii) the affected aircraft and the affected FCS;
  - (iii) the DSG of the affected aircraft;
  - (iv) a list of the FCS introduced by the modification (if it exists);
  - (v) the EASA CS 25.571 certification level for determining the DT data;
  - (vi) a plan for obtaining DT data for each modification (e.g. reliance on the existing STCH or a formal contract with a DAH to produce DT data within a specified compliance time in accordance with EASA CS 26.370);
  - (vii) a DT data implementation schedule for incorporating the DT data into the maintenance programme once it is received;

- (viii) a means of ensuring that the aircraft will not be operated beyond the time limit established for obtaining DT data.
- (9) For modifications that are found during the aircraft survey for repairs, the operator should ensure that DT data is obtained and submitted to CAA for approval. Once approved, the operator should incorporate the DTIs into its maintenance programme no later than 12 months from the date when the modification was identified.

### **6.1.3. Implementation of DTI**

Operators should accomplish the first inspection of a change according to the approved DTI implementation schedule. If the age of the modification is unknown, the operator should use the aircraft age in total flight cycles or total flight hours, as applicable. Where there is any doubt about the applicability of the programme data or the timescales provided in the DAH documentation, CAA should be consulted by the operators concerned.

## **7. ROLE OF THE CAA**

The CAA's role is to verify that the AMP is in compliance with point 26.370 of Part-26 and ensure that their aircraft continuing airworthiness monitoring survey programme takes into account the risks associated with potential non-compliance of operators' or owners' AMPs with the requirements of point 26.370 of Part-26.

**Annex 1 to Appendix 3 to AMC 20-20B (Reserved)**

---

**Annex 2 to Appendix 3 to AMC 20-20B (Reserved)**

---

**Annex 3 to Appendix 3 to AMC 20-20B (Reserved)**

---

**Annex 4 to Appendix 3 to AMC 20-20B (Reserved)**

---

### **Annex 5 to Appendix 3 to AMC 20-20B List of major changes and STCs that may adversely affect fatigue-critical structure**

---

- (1) Passenger-to-freighter conversions (including addition of main deck cargo doors).
- (2) Gross weight increases (increased operating weights, increased zero fuel weights, increased landing weights, and increased maximum take-off weights).
- (3) Installation of fuselage cut-outs (passenger entry doors, emergency exit doors or crew escape hatches, fuselage access doors, and cabin window relocations).
- (4) Complete re-engine or pylon modifications.
- (5) Engine hush kits.
- (6) Wing modifications such as installing winglets or changes in flight control settings (flap droop), and modification of wing trailing edge structure.
- (7) Modified skin splices.
- (8) Antenna installations.
- (9) Any modification that affects several stringer or frame bays.
- (10) Any modification that covers structure requiring periodic inspection by the operator's maintenance programme.
- (11) Any modification that results in operational mission change that significantly changes the manufacturer's load or stress spectrum (e.g. passenger-to-freighter conversion).
- (12) Any modification that changes areas of the fuselage that prevents external visual inspection (e.g. installation of a large external fuselage doubler that results in hiding details beneath it).
- (13) In general, attachment of interior monuments to FCS. Interior monuments include large items of mass such as galleys, closets, and lavatories.

### **Annex 6 to Appendix 3 to AMC 20-20B (Reserved)**

---

## **Appendix 4 to AMC 20-20B Guidelines for the development of a corrosion prevention control programme**

---

### **1. GENERAL**

The TCH should develop a baseline CPCP, which is reviewed by the State of Design. The baseline CPCP is intended to facilitate the development of a CPCP by an operator for their maintenance programme.

The operator should include a CPCP in the maintenance programme, and where a TCH baseline CPCP exists, it should be taken into account in the development of the operator's CPCP. The operator should show that the CPCP is comprehensive in that it addresses all the corrosion likely to affect primary structure, and is systematic in that:

- (a) it provides step-by-step procedures that are applied on a regular basis to each identified task area or zone, and
- (b) these procedures are adjusted when they result in evidence that corrosion is not being controlled to an established acceptable level (Level 1 or better).

#### **1.1 Purpose**

This Appendix gives guidance to operators and DAHs who are developing and implementing a CPCP for aeroplanes maintained in accordance with an aircraft maintenance programme developed in compliance with point M.A.302 of MCAR-M.

CPCPs have been developed by the DAH with the assistance of aircraft operators and national aviation authorities. They relied heavily on service experience to establish CPCP implementation thresholds and repeat intervals. Since that time a logical evaluation process has been developed to ensure environmental damage is considered in the evaluation of aircraft structure. This process is identified in ATA MSG-3 Scheduled maintenance development document, which introduced the CPCP concept in revision 2, circa 1993.

#### **1.2 Approval**

Approval of a TCH CPCP may either be through the MRB (ISC) using existing procedures for MRBR approval, or directly by the State of design if no approved MRBR exists for the type. Provided that the operator has an CAA approved aircraft maintenance programme (AMP) that controls corrosion to Level 1 or better, the operator need not follow exactly the programme offered by the TCH. However, revisions to the TCH's approved programme should be considered by the operator for incorporation in the operator's MP under the MCAR-M requirements.

### **2. DEFINITIONS**

- **Allowable Limit:** this is the amount of material (usually expressed in the thickness of the material) that may be removed or blended out without affecting the ultimate design strength capability of the structural member. Allowable limits may be established by the TCH/DAH.



- **Baseline CPCP:** this is a CPCP developed for a specific model aeroplane. The TCH typically develops the baseline CPCP (see TCH-developed baseline CPCP below). It contains the corrosion inspection tasks, an implementation threshold, and a repeat interval for task accomplishment in each area or zone.
- **Basic task(s):** this is a specific and fundamental set of work elements that should be performed repetitively in all task areas or zones to successfully control corrosion. The contents of the basic task may vary depending upon the specific requirements in an aeroplane area or zone. The basic task is developed to protect the primary structure of the aeroplane.
- **Corrosion prevention and control programme (CPCP):** this is a comprehensive and systematic approach to controlling corrosion in such a way that the load carrying capability of an aircraft structure is not degraded to less than a level necessary to maintain airworthiness. It is based upon the baseline CPCP described above. A CPCP consists of a basic corrosion inspection task, task areas, defined corrosion levels, and compliance times (implementation thresholds and repeat intervals).

The CPCP also includes procedures to notify the CAA of the findings and data associated with Level 2 and Level 3 corrosion and the actions taken to reduce future findings to Level 1.

- **Implementation threshold (IT):** this is the aircraft age associated with the first time the basic corrosion inspection task should be accomplished in an area or zone.
- **Level 1 corrosion is:**
  - Damage occurring between successive inspections that is within the allowable damage limits; or
  - Damage occurring between successive inspections that does not require structural reinforcement, replacement or new damage-tolerance-based inspections; or
  - Corrosion occurring between successive inspections that exceeds the allowable limits but can be attributed to an event not typical of operator usage of other aircraft in the same fleet; or
  - Light corrosion occurring repeatedly between inspections that eventually requires structural reinforcement, replacement, or new damage-tolerance-based inspections.
- **Level 2 corrosion** is any corrosion finding that exceeds Level 1, requiring a review of the operator's CPCP effectiveness, but that is not determined to be Level 3.

The operator is responsible for making the initial determination of the corrosion level, and this may subsequently be adjusted based on consultation with the DAH.

A finding of Level 2 corrosion requires repair, reinforcement, or complete or partial replacement of the applicable structure, or revised fatigue and damage tolerance inspections.

- **Level 3 corrosion** is that corrosion occurring during the first or subsequent accomplishments of an inspection task that the operator or subsequently the TCH or CAA determines to be an urgent airworthiness concern.

*Note:* If Level 3 corrosion is determined at the implementation threshold or any repeat inspection, then it should be reported. Any corrosion that is more than the maximum acceptable to the DAH must be reported in accordance with the current regulations. This determination should be conducted jointly with the DAH.

- **Light corrosion** is corrosion damage so slight that removal and blend-out over multiple repeat intervals may be accomplished before material loss exceeds the allowable limit.
- **Local corrosion.** Generally, local corrosion is corrosion of a skin or web (wing, fuselage, empennage or strut) that does not exceed one frame, stringer, or stiffener bay. Local corrosion is typically limited to a single frame, chord, stringer or stiffener, or corrosion of more than one frame, chord, stringer or stiffener where no corrosion exists on two adjacent members on each side of the corroded member.
- **Repeat Interval (RI):** this is the calendar time between the accomplishment of successive corrosion inspection tasks for a task area or zone.
- **Task area:** this is a region of aircraft structure to which one or more corrosion inspection tasks are assigned. The task area may also be referred to as a zone.
- **TCH-developed baseline CPCP.** The baseline CPCP may be developed as an integral part of the ICA or in a stand-alone section or manual. The TCH should provide an inspection programme that includes the frequency and extent of inspections necessary to ensure the continued airworthiness of the aircraft. Furthermore, the programme should include the information needed to apply protective treatments to the structure after inspection. In order for the inspections to be effectively accomplished, the TCH should include, in the ICA, corrosion removal and cleaning procedures and reference allowable limits. The baseline CPCP is intended to facilitate the operator's development of a CPCP for their maintenance programme.
- **Urgent airworthiness concern:** this is damage that could jeopardise continued safe operation of any aircraft. An urgent airworthiness concern typically requires correction before the next flight and expeditious action to inspect the other aircraft in the operator's fleet.
- **Widespread corrosion:** this is corrosion of two or more adjacent skin or web bays (a web bay is defined by frame, stringer or stiffener spacing). Or widespread corrosion is corrosion of two or more adjacent frames, chords,

stringers, or stiffeners. Or widespread corrosion is corrosion of a frame, chord, stringer, or stiffener and an adjacent skin or web bay.

— **Zone.** See 'Task area'.

### **3. (Reserved)**

## **4. DEVELOPMENT OF OPERATORS PROGRAMME**

### **4.1. Baseline CPCP available**

If a baseline CPCP is available, the operator should use it as a basis for developing their CPCP. In addition to adopting the basic task, task areas, implementation thresholds and repeat intervals of the baseline CPCP, the operator should make provisions for:

- (a) aeroplanes that have exceeded the implementation threshold for certain tasks,
- (b) aeroplanes being removed from storage,
- (c) unanticipated scheduling adjustments,
- (d) corrosion findings made during non-CPCP inspections,
- (e) adding newly acquired aircraft, and
- (f) modifications, configuration changes, and operating environment.

#### **4.1.1. Provisions for aircraft that have exceeded the implementation threshold**

The operator's CPCP must establish a schedule for accomplishing all corrosion inspection tasks in task areas where the aircraft age has exceeded the implementation threshold (see main text of AMC paragraph 12).

#### **4.1.2. Aeroplanes being removed from storage**

Corrosion inspection task intervals are established based on elapsed calendar time. Elapsed calendar time includes time out of service. The operator's CPCP should provide procedures for establishing a schedule for accomplishment of corrosion inspection tasks that have accrued during the storage period.

The schedule should result in accomplishment of all accrued corrosion inspection tasks before the aircraft is placed in service.

#### **4.1.3. Unanticipated scheduling adjustments**

The operator's CPCP should include provisions for adjustment of the repeat interval for unanticipated schedule changes. Such provisions should not exceed 10 % of the repeat interval. The CPCP should include provisions for notifying the CAA when an unanticipated scheduling adjustment is made.

#### **4.1.4. Corrosion findings made during non-CPCP inspections**

Corrosion findings that exceed allowable limits may be found during any scheduled or unscheduled maintenance or inspection activities. These findings may be indicative of an ineffective CPCP. The operator should make provision in their CPCP to evaluate these findings and adjust their CPCP accordingly.

#### **4.1.5. Adding newly acquired aircraft**

Before adding any aircraft to the fleet, the operator should establish a schedule for accomplishing all corrosion inspection tasks in all task areas that are due. This schedule should be established as follows:

- (a) For aircraft that have previously operated under an approved maintenance programme, the initial corrosion inspection task for the new operator must be accomplished in accordance with the previous operator's schedule or in accordance with the new operator's schedule, whichever would result in the earliest accomplishment of the corrosion inspection task.
- (b) For aircraft that have not previously been operated under an approved maintenance programme, each initial corrosion task inspection must be accomplished either before the aircraft is added to the operator's fleet, or in accordance with the schedule approved by the CAA. After each corrosion inspection task has been performed once, the subsequent corrosion task inspections should be accomplished in accordance with the new operator's schedule.

#### **4.1.6. Modifications, configuration changes and operating environment**

The operator must ensure that their CPCP takes account of any modifications, configurations changes and the operating environment applicable to them, that were not addressed in the baseline CPCP documentation.

#### **4.2. Baseline CPCP not available**

If there is no baseline CPCP available for the operator to use in developing their CPCP, the operator should develop their CPCP using the provisions for a baseline CPCP as well as the provisions listed in subparagraphs 4.1.1 through 4.1.6 of this paragraph.

**Appendix 5 to AMC 20-20B — (Reserved)**

---

## AMC 20-21

### AMC 20-21 Programme to enhance aeroplane Electrical Wiring Interconnection System (EWIS) maintenance

---

#### 1 PURPOSE

This AMC provides acceptable means of compliance for developing enhanced EWIS maintenance for operators and maintenance organisations. The information in this AMC is derived from the maintenance, inspection, and alteration best practices identified through extensive research. This AMC provides an acceptable means of compliance with the appropriate certification, maintenance and operating rules. This AMC promotes a housekeeping philosophy of “protect, clean as you go” when performing maintenance, repair, or alterations on or around aircraft EWIS.

#### 2 OBJECTIVE

The objective of this AMC is to enhance the maintenance of aircraft EWIS through adoption by the aviation industry of the following:

- a. Enhanced Zonal Analysis Procedure (EZAP). This AMC presents an “enhanced zonal analysis procedure” and logic that will benefit all aircraft regardless of whether they currently have a structured Zonal Inspection Programme (ZIP). Application of this procedure will ensure that appropriate attention is given to wiring installations. Using EZAP it will be possible to select stand-alone inspections (either general or detailed) and tasks to minimise the presence of combustible material. The procedure and logic in this AMC complement existing zonal analysis procedures and will also allow the identification of new wiring tasks for those aircraft that do not have a structured ZIP.
- b. Guidance for General Visual Inspection (GVI). This AMC provides clarification of the definition for a GVI as well as guidance on what is expected from such an inspection, whether performed as a stand-alone GVI or as part of a zonal inspection. It is assumed this new inspection standard will be the standard applied by operators, or their maintenance provider, when the new tasks are incorporated in to their maintenance programme.
- c. Protection and Caution. This AMC identifies protection and caution to be added to maintenance instructions, thereby enhancing procedures that will lead to minimisation of contamination and accidental damage while working on the aircraft.

The enhanced aircraft wiring maintenance information described in this AMC is intended to improve maintenance and inspection programmes for all aircraft systems. This information, when used appropriately, will improve the likelihood that wiring system degradation, including age-related problems, will be identified and corrected. Therefore, the goal of enhanced wiring maintenance information is to ensure that maintenance actions, such as inspection, repair, overhaul, replacement of parts, and preservation, do not cause a loss of wiring system function, do not

cause an increase in the potential for smoke and fire in the aircraft, and do not inhibit the safe operation of the aircraft.

In order to fully realise the objectives of this AMC, operators, TC holders, STC holders and maintenance providers, will need to rethink their current approach to maintaining and modifying aircraft wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aircraft EWIS should be maintained with the same level of intensity as any other system in the aircraft. They also need to recognise that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulations, especially in small gauge wire may not always be apparent. Therefore effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

Good wiring maintenance practices should contain a "protect, clean as you go" housekeeping philosophy. In other words, care should be taken to protect wire bundles and connectors during work, and to ensure that all shavings, debris and contamination are cleaned up after work is completed. This philosophy is a proactive approach to wiring system health. Wiring needs to be given special attention when maintenance is being performed on it, or around it. This is especially true when performing structural repairs, work under STCs or field approvals, or other modifications.

To fully achieve the objectives of this AMC it is imperative that all personnel performing maintenance on or around EWIS receive appropriate training (see [AMC 20-22](#): Aeroplane EWIS training programme).

### **3 APPLICABILITY**

- a. The guidance provided in this document is directed to operators and maintenance organisations:
- b. The guidance provided in this AMC can be applied to all aeroplane maintenance or inspection programmes.
- c. This AMC, when followed in its entirety, outlines an acceptable means of compliance to the requirement for the development of enhanced scheduled maintenance tasks for the EWIS for the aircraft mentioned in 3a. above.
- d.

### **4 RELATED DOCUMENTS**

- MCAR-CAMO
- MCAR-M
- MCAR-26

### **5 RELATED READING MATERIAL**

- a. EASA AMC 20

- [AMC 20-22](#) Aeroplane EWIS training
- b. FAA Advisory Circulars (AC).
  - AC 25-16 Electrical Fault and Fire Protection and Prevention
  - AC 25.981-1B Fuel Tank Ignition Source Prevention Guidelines
  - AC 43-12A Preventive Maintenance
  - AC 43.13-1B Acceptable Methods, Techniques and Practices for Repairs and Alterations to Aircraft
  - AC 43-204 Visual Inspection For Aircraft
  - AC 43-206 Avionics Cleaning and Corrosion Prevention/Control
  - AC 65-15A Airframe and Powerplant Mechanics Airframe Handbook, Chapter 11, Aircraft Electrical Systems
  - AC 120-YYY Training modules for wiring maintenance

## 6 DEFINITIONS

**Arc tracking:** A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally a result of electrical arcing. Also referred to as "Carbon Arc Tracking," "Wet Arc Tracking," or "Dry Arc Tracking."

**Combustible:** For the purposes of this AMC the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

**Contamination:** For the purposes of this AMC, wiring contamination refers to either of the following:

- The presence of a foreign material that is likely to cause degradation of wiring;
- The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

**Detailed Inspection (DET):** An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

**Electrical Wiring Interconnection System (EWIS):** See EASA CS 25.1701.

**Functional Failure:** Failure of an item to perform its intended function within specified limits.

**General Visual Inspection (GVI):** A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level



of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection: The protection of aeroplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aircraft specific devices, e.g., RF Gaskets.

Maintenance: Refer to MCAR-1. For the purposes of this advisory material, it also includes preventive maintenance.

Maintenance Significant Item (MSI): Items identified by the manufacturer whose failure could result in one or more of the following:

- could affect safety (on ground or in flight);
- is undetectable during operations;
- could have significant operational impact;
- could have significant economic impact.

Needling: The puncturing of a wire's insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

Stand-alone GVI: A GVI which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the stand-alone GVI shall remain an independent step within the work card.

Structural Significant Item (SSI): Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure or control loads and whose failure could affect the structural integrity necessary for the safety of the aircraft.

Swarf: A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

Zonal Inspection: A collective term comprising selected GVI and visual checks that are applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

## **7 BACKGROUND**

Over the years there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. Regulators and Accident Investigators have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft

drinks, and napkins. In some cases dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example a person performing an inspection of an electrical power centre or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

In recent years regulator and industry groups have come to the realisation that current maintenance practices may not be adequate to address aging non-structural systems. While age is not the sole cause of wire degradation, the probability that inadequate maintenance, contamination, improper repair or mechanical damage has caused degradation to a particular EWIS increases over time. Studies by industry and regulator working groups have found that although EWIS management is an important safety issue, there has been a tendency to be complacent about EWIS. These working groups have concluded that there is a need to better manage EWIS so that they continue to function safely.

## **8 WIRE DEGRADATION**

Normal maintenance actions, even using acceptable methods, techniques and practices, can over time be a contributing factor to wire degradation. Zones that are subject to a high level of maintenance activity display more deterioration of the wiring insulation than those areas not subject to frequent maintenance. Degradation of wiring is further accelerated when inappropriate maintenance practices are used. Examples include the practice of needling wires to test the continuity or voltage, and using a metal wire or rod as a guide to feed new wires into an existing bundle. These practices could cause a breach in the wiring insulation that can contribute to arcing.

Over time, insulation can crack or breach, thereby exposing the conductor. This breakdown, coupled with maintenance actions, can exacerbate EWIS malfunction. Wiring that is undisturbed will have less degradation than wiring that is disturbed during maintenance.

For additional information on the principle causes of wire degradation see [Appendix E](#).

## **9 INSPECTION OF EWIS**

Typical analytical methods used for the development of maintenance programmes have not provided a focus on wiring. As a result most operators have not adequately addressed deterioration of EWIS in their programmes.

CAA believes that it would be beneficial to provide guidance on the type of deterioration that a person performing a GVI, DET, or zonal inspection would be expected to discover. Though it may be realistically assumed that all operators provide such guidance to their inspectors, it is evident that significant variations exist and, in certain areas of the world, a significant enhancement of the inspection

could be obtained if internationally agreed guidance material could be produced. The guidance provided by this AMC assumes each operator will adopt recent improvements made to the definitions of GVI and DET inspections. This information should be incorporated in operators' training material and in the introductory section of maintenance planning documentation.

This section is divided into three parts. The first part addresses the levels of inspection applicable to EWIS, the second part provides guidance for performing zonal inspections, and the third part provides lists of installations and areas of concern.

a. Levels of inspection applicable to EWIS

(1) Detailed Inspection (DET)

An intensive examination of a specific item, installation or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

A DET can be more than just a visual inspection since it may include tactile assessment in which a component or assembly is checked for tightness/security. This is of particular significance when identifying applicable and effective tasks to ensure the continued integrity of installations such as bonding jumpers, terminal connectors, etc.

Though the term Detailed Visual Inspection remains valid for DET using only eyesight, it should be recognised that this may represent only part of the inspection called for in the source documents used to establish an operator's Maintenance Programme. For this reason it is recommended that the acronym "DVI" not be used since it excludes tactile examination from this level of inspection.

(2) General Visual Inspection (GVI).

A visual examination of an interior or exterior area, installation or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Recent changes to this definition have added proximity guidance (within touching distance) and the allowance to use a mirror to enhance visual access to exposed surfaces when performing a GVI. These changes should result in more consistent application of GVI and support the

expectations of what types of EWIS discrepancies should be detected by a GVI.

Though flashlights and mirrors may be required to provide an adequate view of all exposed surfaces, there is no requirement for equipment removal or displacement unless this is specifically called for in the access instructions. Paint and/or sealant removal is not necessary and should be avoided unless the observed condition is suspect. Should unsatisfactory conditions be suspected, items may need to be removed or displaced in order to permit proper assessment.

It is expected that the area to be inspected is clean enough to minimise the possibility that accumulated dirt or grease might hide unsatisfactory conditions that would otherwise be obvious. Any cleaning that is considered necessary should be performed in accordance with accepted procedures in order to minimise the possibility of the cleaning process itself introducing anomalies.

In general, the person performing a GVI is expected to identify degradation due to wear, vibration, moisture, contamination, excessive heat, aging, etc., and make an assessment as to what actions are appropriate to address the noted discrepancy. In making this assessment, any potential effect on adjacent system installations should be considered, particularly if these include wiring. Observations of discrepancies, such as chafing, broken clamps, sagging, interference, contamination, etc., need to be addressed.

(3) Zonal Inspection

A collective term comprising selected GVI and visual checks that are applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

A zonal inspection is essentially a GVI of an area or zone to detect obvious unsatisfactory conditions and discrepancies. Unlike a stand-alone GVI, it is not directed to any specified component or assembly.

b. Guidance for zonal inspections

The following EWIS degradation items are typical of what should be detectable and subsequently addressed as a result of a zonal inspection (as well as a result of a stand-alone GVI). It is also recommended that these items be included in maintenance and training documentation. This list is not intended to be exhaustive and may be expanded as considered appropriate.

(1) Wire/Wire Harnesses

- Wire bundle/wire bundle or wire bundle/structure contact/chafing
- Wire bundle sagging or improperly secured

- Wires damaged (obvious damage due to mechanical impact, overheating, localised chafing, etc.)
  - Lacing tape and/or ties missing/incorrectly installed
  - Wiring protection sheath/conduit deformity or incorrectly installed
  - End of sheath rubbing on end attachment device
  - Grommet missing or damaged
  - Dust and lint accumulation
  - Surface contamination by metal shavings/swarf
  - Contamination by liquids
  - Deterioration of previous repairs (e.g., splices)
  - Deterioration of production splices
  - Inappropriate repairs (e.g., incorrect splice)
  - Inappropriate attachments to or separation from fluid lines
- (2) Connectors
- External corrosion on receptacles
  - Backshell tail broken
  - Rubber pad or packing on backshell missing
  - No backshell wire securing device
  - Foolproofing chain broken
  - Missing or broken safety wire
  - Discoloration/evidence of overheating on terminal lugs/blocks
  - Torque stripe misalignment
- (3) Switches
- Rear protection cap damaged
- (4) Ground points
- Corrosion
- (5) Bonding braid/bonding jumper
- Braid broken or disconnected
  - Multiple strands corroded
  - Multiple strands broken
- (6) Wiring clamps or brackets
- Corroded
  - Broken/missing

- Bent or twisted
  - Faulty attachment (bad attachment or fastener missing)
  - Unstuck/detached
  - Protection/cushion damaged
- (7) Supports (rails or tubes/conduit)
- Broken
  - Deformed
  - Fastener missing
  - Missing edge protection on rims of feed through holes
  - Racetrack cushion damaged
  - Obstructed drainage holes (in conduits)
- (8) Circuit breakers, contactors or relays
- Signs of overheating
  - Signs of arcing
- c. Wiring installations and areas of concern

Research has shown that the following installations and areas need to be addressed in existing maintenance material.

(1) Wiring installations

Clamping points – Wire chafing is aggravated by damaged clamps, clamp cushion migration, or improper clamp installations. Aircraft manufacturers specify clamp type and part number for EWIS throughout the aircraft. When replacing clamps use those specified by the aircraft manufacturer. Tie wraps provide a rapid method of clamping especially during line maintenance operations. Improperly installed tie wraps can have a detrimental effect on wire insulation. When new wiring is installed as part of a STC or any other modification the drawings will provide wiring routing, clamp type and size, and proper location. Examples of significant wiring modifications are the installation of new avionics systems, new galley installations and new instrumentation. Wire routing, type of clamp and clamping location should conform to the approved drawings. Adding new wire to existing wire bundles may overload the clamps causing wire bundle to sag and wires to chafe. Raceway clamp foam cushions may deteriorate with age, fall apart, and consequently would not provide proper clamping.

Connectors – Worn environmental seals, loose connectors, missing seal plugs, missing dummy contacts, or lack of strain relief on connector grommets can compromise connector integrity and allow contamination to enter the connector, leading to corrosion or grommet degradation. Connector pin corrosion can cause overheating, arcing and pin-to-pin

shorting. Drip loops should be maintained when connectors are below the level of the harness and tight bends at connectors should be avoided or corrected.

Terminations – Terminations, such as terminal lugs and terminal blocks, are susceptible to mechanical damage, corrosion, heat damage and contamination from chemicals, dust and dirt. High current-carrying feeder cable terminal lugs can over time lose their original torque value due to vibration. One sign of this is heat discoloration at the terminal end. Proper build-up and nut torque is especially critical on high current carrying feeder cable lugs. Corrosion on terminal lugs and blocks can cause high resistance and overheating. Dust, dirt and other debris are combustible and therefore could sustain a fire if ignited from an overheated or arcing terminal lug. Terminal blocks and terminal strips located in equipment power centres (EPC), avionics compartments and throughout the aircraft need to be kept clean and free of any combustibles.

Backshells – Wires may break at backshells, due to excessive flexing, lack of strain relief, or improper build-up. Loss of backshell bonding may also occur due to these and other factors.

Sleeving and Conduits – Damage to sleeving and conduits, if not corrected, may lead to wire damage. Therefore, damage such as cuts, dents and creases on conduits may require further investigation for condition of wiring within.

Grounding Points – Grounding points should be checked for security (i.e., finger tightness), condition of the termination, cleanliness, and corrosion. Any grounding points that are corroded or have lost their protective coating should be repaired.

Splices – Both sealed and non-sealed splices are susceptible to vibration, mechanical damage, corrosion, heat damage, chemical contamination, and environmental deterioration. Power feeder cables normally carry high current levels and are very susceptible to installation error and splice degradation. All splices should conform to the TC or STC holder's published recommendations. In the absence of published recommendations, environmental splices are recommended to be used.

(2) Areas of concern

Wire Raceways and Bundles – Adding wires to existing wire raceways may cause undue wear and chafing of the wire installation and inability to maintain the wire in the raceway. Adding wire to existing bundles may cause wire to sag against the structure, which can cause chafing.

Wings – The wing leading and trailing edges are areas that experience difficult environments for wiring installations. The wing leading and trailing edge wiring is exposed on some aircraft models whenever the

flaps or slats are extended. Other potential damage sources include slat torque shafts and bleed air ducts.

Engine, Pylon, and Nacelle Area – These areas experience high vibration, heat, frequent maintenance, and are susceptible to chemical contamination.

Accessory compartment and equipment bays – These areas typically contain items such as electrical components, pneumatic components and ducting, hydraulic components and plumbing, and may be susceptible to vibration, heat, and liquid contamination.

Auxiliary Power Unit (APU) – Like the engine/nacelle area, the APU is susceptible to high vibration, heat, frequent maintenance, and chemical contamination.

Landing Gear and Wheel Wells – This area is exposed to severe external environmental conditions in addition to vibration and chemical contamination.

Electrical Panels and Line Replaceable Units (LRU) – Panel wiring is particularly prone to broken wires and damaged insulation when these high density areas are disturbed during troubleshooting activities, major modifications, and refurbishments. Wire damage may be minimised by tying wiring to wooden dowels to reduce wire disturbance during modification. There may be some configurations where connector support brackets would be more desirable and cause less disturbance of the wiring than removal of individual connectors from the supports.

Batteries – Wires in the vicinity of all aircraft batteries are susceptible to corrosion and discoloration. These wires should be inspected for corrosion and discoloration. Discoloured wires should be inspected for serviceability.

Power Feeders – High current wiring and associated connections have the potential to generate intense heat. Power feeder cables, terminals, and splices may be subject to degradation or loosening due to vibration. If any signs of overheating are seen, splices or termination should be replaced. Depending on design, service experience may highlight a need to periodically check for proper torque of power feeder cable terminal ends, especially in high vibration areas. This applies to galley and engine/APU generator power feeders.

Under Galleys, Lavatories, and Cockpit – Areas under the galleys, lavatories, and cockpit, are particularly susceptible to contamination from coffee, food, water, soft drinks, lavatory fluids, dust, lint, etc. This contamination can be minimised by adherence to proper floor panel sealing procedures in these areas.

Fluid Drain plumbing – Leaks from fluid drain plumbing may lead to liquid contamination of wiring. In addition to routine visual inspections,



service experience may highlight a need for periodic leak checks or cleaning.

Fuselage Drain provisions – Some installations include features designed to catch leakage that is plumbed to an appropriate exit. Blockage of the drain path can result in liquid contamination of wiring. In addition to routine visual inspections, service experience may highlight that these installations and associated plumbing should be periodically checked to ensure the drain path is free of obstructions.

Cargo Bay/Underfloor – Damage to wiring in the cargo bay underfloor can occur due to maintenance activities in the area.

Wiring subject to movement – Wiring that is subject to movement or bending during normal operation or maintenance access should be inspected at locations such as doors, actuators, landing gear mechanisms, and electrical access panels.

Access Panels – Wiring near access panels may receive accidental damage as a result of repetitive maintenance access and thus may warrant special attention.

Under Doors – Areas under cargo, passenger and service entry doors are susceptible to fluid ingress from rain, snow and liquid spills. Fluid drain provisions and floor panel sealing should be periodically inspected and repaired as necessary.

Under Cockpit Sliding Windows – Areas under cockpit sliding windows are susceptible to water ingress from rain and snow. Fluid drain provisions should be periodically inspected and repaired as necessary.

Areas where wiring is difficult to access – Areas where wiring is difficult to access (e.g., flight deck instrument panels, cockpit pedestal area) may accumulate excessive dust and other contaminants as a result of infrequent cleaning. In these areas it may be necessary to remove components and disassemble other systems to facilitate access to the area.

## **10 ENHANCED ZONAL ANALYSIS PROCEDURE (EZAP)**

The EZAP is designed to permit appropriate attention to be given to electrical wiring installations. This is achieved by providing a means to identify applicable and effective tasks to minimise accumulation of combustible materials and address wiring installation discrepancies that may not otherwise be reliably detected by inspections contained in existing maintenance programmes.

## **11 MAINTENANCE PRACTICES: PROTECTION AND CAUTION RECOMMENDATIONS**

CAA has identified some specific maintenance and servicing tasks for which more robust practices are recommended to be adopted by operators, and/or

maintenance providers. These recommendations apply to all tasks, including those performed on an unscheduled basis without an accompanying routine job instruction card. Performance of these maintenance practices will help prevent contamination of EWIS that result from contact with harmful solids (such as metal shavings) or fluids during maintenance, modifications, and repairs of aeroplane structures, and components. In addition, the training of maintenance and servicing personnel should address the potential consequences of their actions on the wiring in the work vicinity.

a. Item 1: Installation, repair, or modification to wiring.

Wiring and its associated components (protective coverings, connectors, clamping provisions, conduits, etc.) often comprise the most delicate and maintenance-sensitive portions of an installation or system. Extreme care should be exercised and proper procedures used during installation, repair, or modification of wiring to ensure safe and reliable performance of the function supplied by the wiring.

Proper wire selection, routing/separation, clamping configurations, use of splices, repair or replacement of protective coverings, pinning/de-pinning of connections, etc., should be performed in accordance with the applicable sections of the Aircraft Maintenance Manual (AMM), Wiring Practices Manual (WPM), or other documents authorised for maintenance use. In addition, special care should be taken to minimise disturbance of existing adjacent wiring during all maintenance activities. When wiring is displaced during a maintenance activity, special attention should be given to returning it to its normal configuration in accordance with the applicable maintenance instructions.

b. Item 2: Structural repairs, STC, modifications.

Structural repair, STC or modification activity inherently introduces tooling and residual debris that is harmful to aircraft wiring. Structural repairs or modifications often require displacement (or removal) of wiring to provide access to the work area. Even minor displacement of wiring, especially while clamped, can damage wire insulation, which can result in degraded performance, arcing, or circuit failure.

Extreme care should be exercised to protect wiring from mechanical damage by tools or other equipment used during structural repairs, STC or modifications. Drilling blindly into the aircraft structure should be avoided. Damage to wire installation could cause wire arcing, fire and smoke. Wiring located adjacent to drilling or riveting operations should be carefully displaced or covered to reduce the possibility of mechanical damage.

Debris such as drill shavings, liberated fastener pieces, broken drill bits, etc., should not be allowed to contaminate or penetrate wiring or electrical components. This can cause severe damage to insulation and potential arcing by providing a conductive path to ground or between two or more wires of different loads. Once contaminated, removal of this type of debris from wire

bundles is extremely difficult. Therefore, precautions should be taken to prevent contamination of any kind from entering the wire bundle.

Before initiating structural repair, STC or modification activity, the work area should be carefully surveyed to identify all wiring and electrical components that may be subject to contamination. All wiring and electrical components in the debris field should be covered or removed to prevent contamination or damage. Consideration should be given to using drills equipped with vacuum aspiration to further minimise risk of metallic debris contaminating wire bundles. Clean electrical components and wiring after completion of work per applicable maintenance instructions.

c. Item 3: Aircraft De-Icing or Anti-Icing.

In order to prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear, care should be exercised when spraying de/anti-icing fluids. Direct pressure spray onto electrical components and wiring can lead to contamination or degradation and thus should be avoided.

d. Item 4: Inclement weather.

EWIS in areas below doorways, floors, access panels, and servicing bays are prone to corrosion or contamination due to their exposure to the elements. Snow, slush, or excessive moisture should be removed from these areas before closing doors or panels. Remove deposits of snow/slush from any items (e.g. cargo containers) before loading in the aircraft. During inclement weather, keep doors/panels closed as much as possible to prevent ingress of snow, slush, or excessive moisture that could increase potential for EWIS degradation.

e. Item 5: Component removal/installation (relating to attached wiring).

Excessive handling and movement during removal and installation of components may be harmful to aircraft wiring. Use appropriate connector pliers (e.g. soft jawed) to loosen coupling rings that are too tight to be loosened by hand. Alternately, pull on the plug body and unscrew the coupling ring until the connector is separated. Do not use excessive force, and do not pull on attached wires. When reconnecting, special care should be taken to ensure the connector body is fully seated, the jam nut is fully secured, and no tension is on the wires.

When equipment is disconnected, use protective caps on all connectors (plug or receptacle) to prevent contamination or damage of the contacts. Sleeves or plastic bags may be used if protective caps are not available. Use of sleeves or plastic bags should be temporary because of the risk of condensation. It is recommended to use a humidity absorber with sleeves or plastic bags.

f. Item 6: Pressure Washing.

In order to prevent damage to exposed electrical components and wiring in areas such as wing leading and trailing edges, wheelwells, and landing gear,

care should be exercised when spraying water or cleaning fluids. Direct high-pressure spraying onto electrical components and wiring can lead to contamination or degradation and should be avoided. When practical, wiring and connectors should be protected before pressure washing. Water rinse should be used to remove cleaning solution residue after washing. Breakdown of wire insulation may occur with long term exposure of wiring to cleaning solutions. Although these recommendations are good practice and technique, the aeroplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions regarding pressure washing.

g. Item 7: Cleaning of EWIS (in situ).

Extreme care should be exercised and proper procedures used during cleaning to ensure safe and reliable performance of the function supplied by the wiring.

Care should be taken to avoid displacement or disturbance of wiring during cleaning of non-aggressive contamination. However, in the event of contamination by aggressive contaminants (e.g. livestock waste, salt water, battery electrolyte, etc.) such displacement may be necessary. In these cases wiring should be released from its installation so as to avoid undue stress being induced in wiring or connectors. Similarly, if liquid contamination enters the bundle, then ties should be removed before separating the wires. Although these recommendations for cleaning of EWIS are considered good practice and technique, the aeroplane maintenance manual or STC holder's instructions should be consulted for additional detailed instructions.

Clean only the area and items that have contamination. Before cleaning, make sure that the cleaning materials and methods will not cause more contamination. If a cloth is used, make sure that it is clean, dry, and lint-free. A connector should be completely dry before mating. Any fluids remaining on a connector can have a deteriorating affect on the connector or the system or both.

h. Item 8: Servicing, modifying, or repairing waste/water systems.

EWIS in areas adjacent to waste/water systems are prone to contamination from those systems. Care should be exercised to prevent any fluids from reaching electrical components and wiring while servicing, modifying, or repairing waste/water systems. Cover exposed electrical components and wiring during waste/water system modification or repair. Operator practice may call for a weak acid solution to be periodically flushed through lavatory systems to enhance reliability and efficiency of operation. In view of the effect of acid contamination on systems and structure, the system should be confirmed to be free of leaks before using such solutions.

i. Item 9: Servicing, modifying, or repairing oil systems.

Electrical wiring interconnections in areas adjacent to oil systems are prone to contamination from those systems. To minimise the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching

electrical components and wiring while servicing, modifying, or repairing oil systems. Oil and debris in combination with damaged wiring can present a fire hazard.

- j. Item 10: Servicing, modifying, or repairing hydraulic systems.

EWIS in areas adjacent to hydraulic systems are prone to contamination from those systems. To minimise the attraction and adhesion of foreign material, care should be exercised to avoid any fluids from reaching electrical components and wiring while servicing, modifying, or repairing hydraulic systems.

- k. Item 11: Gaining access (entering zones).

When entering or working on the aircraft, care should be exercised to prevent damage to adjacent or hidden electrical components and wiring, including wiring that may be hidden from view (e.g., covered by insulation blankets). Use protective boards or platforms for adequate support and protection. Avoid using wire bundles as handholds, steps and supports. Work lights should not be hung or supported by wiring. If wiring must be displaced (or removed) for work area access, it should be adequately released from its clamping (or other restraining provisions) to allow movement without damage and returned after work is completed.

- l. Item 12: Application of Corrosion Preventions Compounds (CPC).

When applying CPC in aeroplane zones containing wire and associated components (i.e. clamps, connectors and ties), care should be taken to prevent CPC from coming in contact with the wire and components. Dust and lint is more likely to collect on wire that has CPC on it. Application of CPC should be done in accordance with the aircraft manufacturer's recommendations.

## 12 CHANGES

The programme to enhance EWIS maintenance also applies to EWIS installed, modified, or affected by changes or STC. Changes that could affect EWIS include, but are not limited to, those that install new equipment in close proximity to wiring, introduce a heat source in the zone, or introduce potential sources of combustible material or harmful contamination into the zone.

The owner/operator is responsible for determining if the EWIS has been changed (or affected by a change) and ensuring that their maintenance programme is enhanced as appropriate.

**Appendix A to AMC 20-21 (Reserved)**

---

**Appendix B to AMC 20-21 (Reserved)**

---

**Appendix C to AMC 20-21 (Reserved)**

---

**Appendix D to AMC 20-21 (Reserved)**

---

## **Appendix E to AMC 20-21 Causes of Wire Degradation**

---

The following items are considered principal causes of wiring degradation and should be used to help focus maintenance programmes:

Vibration - High vibration areas tend to accelerate degradation over time, resulting in “chattering” contacts and intermittent symptoms. High vibration of tie-wraps or string-ties can cause damage to insulation. In addition, high vibration will exacerbate any existing problem with wire insulation cracking.

Moisture - High moisture areas generally accelerate corrosion of terminals, pins, sockets, and conductors. It should be noted that wiring installed in clean, dry areas with moderate temperatures appears to hold up well.

Maintenance - Scheduled and unscheduled maintenance activities, if done improperly, may contribute to long-term problems and wiring degradation. Certain repairs may have limited durability and should be evaluated to ascertain if rework is necessary. Repairs that conform to manufacturers recommended maintenance practices are generally considered permanent and should not require rework. Furthermore, care should be taken to prevent undue collateral damage to EWIS while performing maintenance on other systems.

Metal shavings and debris have been discovered on wire bundles after maintenance, repairs, modifications, or STC have been performed. Care should be taken to protect wire bundles and connectors during modification work. The work areas should be cleaned while the work progresses to ensure that all shavings and debris are removed; the work area should be thoroughly cleaned after the work is complete; and the work area should be inspected after the final cleaning.

Repairs should be performed using the most effective methods available. Since wire splices are more susceptible to degradation, arcing, and overheating, the recommended method of repairing a wire is with an environmental splice.

Indirect Damage - Events such as pneumatic duct ruptures or duct clamp leakage can cause damage that, while not initially evident, can cause wiring problems at a later stage. When events such as these occur, surrounding EWIS should be carefully inspected to ensure that there is no damage or no potential for damage is evident. The indirect damage caused by these types of events may be broken clamps or ties, broken wire insulation, or even broken conductor strands. In some cases the pressure of the duct rupture may cause wire separation from the connector or terminal strip.

Contamination - Wire contamination refers to either of the following situations:

- a. The presence of a foreign material that is likely to cause degradation of wiring.
- b. The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

The contaminant may be in solid or liquid form. Solid contaminants such as metal shavings, swarf, debris, livestock waste, lint and dust can accumulate on wiring and may degrade or penetrate wiring or electrical components.

Chemicals in fluids such as hydraulic fluid, battery electrolytes, fuel, corrosion inhibiting compounds, waste system chemicals, cleaning agents, de-icing fluids, paint, soft drinks and coffee can contribute to degradation of wiring.

Hydraulic fluids, de-icing fluids and battery electrolyte require special consideration. These fluids, although essential for aircraft operation, can damage connector grommets, wire bundle clamps, wire ties and wire lacing, causing chafing and arcing. Wiring exposed to these fluids should be given special attention during inspection. Contaminated wire insulation that has visible cracking or breaches to the core conductor can eventually arc and cause a fire. Wiring exposed to, or in close proximity to, any of these chemicals may need to be inspected more frequently for damage or degradation.

When cleaning areas or zones of the aircraft that contain both wiring and chemical contaminants, special cleaning procedures and precautions may be needed. Such procedures may include wrapping wire and connectors with a protective covering prior to cleaning. This would be especially true if pressure-washing equipment is utilised. In all cases the aircraft manufacturer recommended procedures should be followed.

Waste system spills also require special attention. Service history has shown that these spills can have detrimental effects on aircraft EWIS and have resulted in smoke and fire events. When this type of contamination is found all affected components in the EWIS should be thoroughly cleaned, inspected and repaired or replaced if necessary. The source of the spill or leakage should be located and corrected.

Heat - Exposure to high heat can accelerate degradation of wiring by causing insulation dryness and cracking. Direct contact with a high heat source can quickly damage insulation. Burned, charred or even melted insulation are the most likely indicators of this type of damage. Low levels of heat can also degrade wiring over a longer period of time. This type of degradation is sometimes seen on engines, in galley wiring such as coffee makers and ovens, and behind fluorescent lights, especially the ballasts.



## AMC 20-22

### AMC 20-22 Aeroplane Electrical Wiring Interconnection System Training Programme

---

#### 1 PURPOSE

This AMC provides acceptable means of compliance for developing an enhanced Electrical Wiring Interconnection System (EWIS) training programme. The information in this AMC is derived from the best practices training developed through extensive research. This AMC is an effort by the CAA to officially endorse these best practices and to dispense this information industry-wide so that the benefits of this information can be effectively realised. Following this AMC will result in a training programme that will improve the awareness and skill level of the aviation personnel in EWIS production, modification, maintenance, inspection, alterations and repair. This AMC promotes a philosophy of training for all personnel who come into contact with aeroplane EWIS as part of their job and tailors the training for each workgroup to their particular needs.

#### 2 OBJECTIVE

This AMC has been published in order to provide the approved organisations with acceptable means of compliance to comply with their training obligations as required in paragraphs 145.A.30 and 145.A.35 of MCAR-145 and CAMO.A.305 of MCAR-CAMO with respect to EWIS.

To fully realise the objectives of this AMC, operators, holders of type certificates (TC), holders of supplemental type certificates (STC), maintenance organisations and persons performing modifications or repairs, will need to rethink their current approach to maintaining and modifying aeroplane wiring and systems. This may require more than simply updating maintenance manuals and work cards and enhancing training. Maintenance personnel need to be aware that aeroplane EWIS should be maintained with the same level of intensity as any other system in the aeroplane. They also need to recognise that visual inspection of wiring has inherent limitations. Small defects such as breached or cracked insulation, especially in small gage wire may not always be apparent. Therefore, effective wiring maintenance combines visual inspection techniques with improved wiring maintenance practices and training.

The objective of this EWIS training programme is to give operators, holders of TC, holders of STC, maintenance organisations and persons performing field approval modifications or repairs a model for the development of their own EWIS training programme. This will ensure that proper procedures, methods techniques, and practices are used when performing maintenance, preventive maintenance, inspection, alteration, and cleaning of EWIS.

The training syllabus and curriculum for those personnel directly involved in the maintenance and inspection of EWIS, identified as Target Group 1 and 2, are in [Appendix A](#) and [C](#) to this AMC.

This AMC also provides guidance on the development of EWIS training programmes for personnel who are not directly involved in the maintenance and inspection of EWIS. Although there is no direct regulatory requirement for EWIS training of these personnel, operators may choose to provide EWIS training. The training syllabus and curriculum for these personnel, identified as Target Groups 3 through 8, are in [Appendix B](#) and [C](#) to this AMC.

It is believed that training personnel in these groups would greatly enhance awareness of the importance of EWIS safety in the overall safe operation of aeroplanes. Although these groups are not directly involved in the maintenance of EWIS, they have the potential to have an adverse impact on EWIS. This can occur through inadvertent contact with EWIS during aeroplane cleaning or when individuals perform unrelated maintenance that could impact the integrity of EWIS. Mechanics leaving drill shavings on wire bundles is one example of how this could occur. Some people prepare paperwork that guides mechanics, training this target group in EWIS should help to ensure that proper attention is paid to EWIS issues.

This programme was developed for eight different target groups and may be used for the minimum requirements for initial and recurrent training (see training matrix). Depending on the duties, some may fall into more than one target group and, therefore, must fulfil all objectives of the associated target groups. The target groups are:

- a. Qualified staff performing EWIS maintenance.  
These staff members are personnel who perform wiring systems maintenance and their training is based on their job description and the work being done by them (e.g. avionics skilled workers or technicians cat B2).
- b. Qualified staff performing maintenance inspections on wiring systems.  
These staff members are personnel who perform EWIS inspections (but not maintenance), and their training is based on their job description and the work being done by them (e.g. inspectors/technicians cat B2).
- c. Qualified staff performing electrical/avionic engineering on in-service aeroplane.  
These staff members are personnel who are authorised to design EWIS installations, modifications and repairs (e.g. electric/avionic engineers).
- d. Qualified staff performing general maintenance/inspections not involving wire maintenance (LRU change is not considered wire maintenance).  
These staff members are personnel who perform maintenance on aeroplane that may require removal/reconnection of electrical connective devices (e.g. inspectors/technicians cat A or B1).

- e. Qualified staff performing other engineering or planning work on in-service aeroplane.

These staff members are personnel who are authorised to design mechanical/structure systems installations, modifications and repairs, or personnel who are authorised to plan maintenance tasks.

- f. Other service staff with duties in proximity to EEWIS.

These staff members are personnel whose duties would bring them into contact/view of aeroplane wiring systems. This would include, but not be limited to: Aeroplane cleaners, cargo loaders, fuelers, lavatory servicing personnel, de-icing personnel, push back personnel.

- g. Flight Deck Crew.  
(E.g. Pilots, Flight Engineers)
- h. Cabin Crew.

### 3 APPLICABILITY

This AMC describes acceptable means, but not the only means, of compliance with the appropriate certification, maintenance and operating regulations.

The information in this AMC is based on lessons learned by Aging Transport Systems Rulemaking Advisory Committee (ATSRAC) Harmonised Working Groups, regulatory authorities, manufacturers, airlines and repair stations. This AMC can be applied to any aeroplane training programme.

### 4 RELATED DOCUMENTS

- MCAR-CAMO
- MCAR-145

### 5 RELATED READING MATERIAL

- a. EASA AMC-20
  - [AMC 20-21](#) Programme to Enhance Aeroplane Electrical Wiring Interconnection System Maintenance

### 6 DEFINITIONS

Arc tracking: A phenomenon in which a conductive carbon path is formed across an insulating surface. This carbon path provides a short circuit path through which current can flow. Normally, a result of electrical arcing. Also referred to as "Carbon Arc Tracking", "Wet Arc Tracking", or "Dry Arc Tracking".

Combustible: For the purposes of this AMC, the term combustible refers to the ability of any solid, liquid or gaseous material to cause a fire to be sustained after removal of the ignition source. The term is used in place of inflammable/flammable. It should not be interpreted as identifying material that will burn when subjected to a continuous source of heat as occurs when a fire develops.

Contamination: For the purposes of this AMC, wiring contamination refers to either of the following:

- The presence of a foreign material that is likely to cause degradation of wiring.
- The presence of a foreign material that is capable of sustaining combustion after removal of ignition source.

Detailed Inspection (DET): An intensive examination of a specific item, installation, or assembly to detect damage, failure or irregularity. Available lighting is normally supplemented with a direct source of good lighting at an intensity deemed appropriate. Inspection aids such as mirrors, magnifying lenses or other means may be necessary. Surface cleaning and elaborate access procedures may be required.

Electrical Wiring Interconnection System (EWIS): See EASA CS 25.1701.

Functional Failure: Failure of an item to perform its intended function within specified limits.

General Visual Inspection (GVI): A visual examination of an interior or exterior area, installation, or assembly to detect obvious damage, failure or irregularity. This level of inspection is made from within touching distance unless otherwise specified. A mirror may be necessary to enhance visual access to all exposed surfaces in the inspection area. This level of inspection is made under normally available lighting conditions such as daylight, hangar lighting, flashlight or droplight and may require removal or opening of access panels or doors. Stands, ladders or platforms may be required to gain proximity to the area being checked.

Lightning/High Intensity Radiated Field (L/HIRF) protection: The protection of aeroplane electrical systems and structure from induced voltages or currents by means of shielded wires, raceways, bonding jumpers, connectors, composite fairings with conductive mesh, static dischargers, and the inherent conductivity of the structure; may include aeroplane specific devices, e.g., RF Gaskets.

Maintenance: As defined in Regulation (EC) 2042/2003 Article 2(h) “maintenance means inspection, overhaul, repair, preservation, and the replacement of parts, but excludes preventive maintenance.” For the purposes of this advisory material, it also includes preventive maintenance.

Maintenance Significant Item (MSI): Items identified by the manufacturer whose failure:

- could affect safety (on ground or in flight).
- is undetectable during operations.
- could have significant operational impact.

- could have significant economic impact.

**Needling:** The puncturing of a wire's insulation to make contact with the core to test the continuity and presence of voltage in the wire segment.

**Stand-alone General Visual Inspection (GVI):** A GVI which is not performed as part of a zonal inspection. Even in cases where the interval coincides with the zonal inspection, the stand-alone GVI shall remain an independent step within the work card.

**Structural Significant Item (SSI):** Any detail, element or assembly that contributes significantly to carrying flight, ground, pressure, or control loads and whose failure could affect the structural integrity necessary for the safety of the aeroplane.

**Swarf:** A term used to describe the metal particles, generated from drilling and machining operations. Such particles may accumulate on and between wires within a wire bundle.

**Zonal Inspection:** A collective term comprising selected GVI and visual checks that are applied to each zone, defined by access and area, to check system and powerplant installations and structure for security and general condition.

## 7 BACKGROUND

Over the years there have been a number of in-flight smoke and fire events where contamination sustained and caused the fire to spread. Regulators and Accident Investigators have conducted aircraft inspections and found wiring contaminated with items such as dust, dirt, metal shavings, lavatory waste water, coffee, soft drinks, and napkins. In some cases, dust has been found completely covering wire bundles and the surrounding area.

Research has also demonstrated that wiring can be harmed by collateral damage when maintenance is being performed on other aircraft systems. For example, a person performing an inspection of an electrical power centre or avionics compartment may inadvertently cause damage to wiring in an adjacent area.

Aviation Accident Investigators have specifically cited the need for improved training of personnel to ensure adequate recognition and repair of potentially unsafe wiring conditions.

This AMC addresses only the training programme. It does not attempt to deal with the condition of the fleet's wiring, or develop performance tests for wiring.

## 8 ESSENTIAL ELEMENTS FOR A TRAINING PROGRAMME

### a. Initial Training.

Initial training should be conducted for each designated work group. The initial training for each designated work group is outlined in EWIS Minimum Initial Training Programme - [Appendix A](#) and [B](#). Curriculum and Lesson Plans for each dedicated module are included in [Appendix C](#).

The most important criteria are to meet the objectives of the Lesson Plans – [Appendix C](#) (using classroom discussion, computer-based training or hands-on practical training).

Assessment or achieving the objectives should be at the discretion of the training organisation (such as written test, oral test or demonstration of skills).

Supporting documentation such as AMC is an integral part of training and should be used to support development of the Curriculum and Lesson Plans.

b. Refresher Training.

Refresher training should be conducted in a period not exceeding two years. It could consist of a review of previously covered material plus any new material or revisions to publications. Refresher training will follow the EWIS Minimum Initial Training Programme - [Appendix A](#) or [B](#) for that particular target group.

## Appendix A to AMC 20-22 – EWIS Minimum Initial Training Programme for Group 1 and 2

Target Group 1: Qualified staff performing EWIS maintenance.

Target Group 2: Qualified staff performing maintenance inspections on EWIS.

TARGET GROUP	1	2
<b>A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES</b> <b>Know or demonstrate safe handling of aeroplane electrical systems, line replaceable units (LRU), tooling, troubleshooting procedures, and electrical measurement.</b>		
1. Safety practices	X	X
2. Electrostatic discharge sensitive (ESDS) device handling and protection	X	X
3. Tools, special tools, and equipment	X	
4. Verifying calibration/certification of instruments, tools, and equipment	X	
5. Required wiring checks using the troubleshooting procedures and charts	X	
6. Measurement and troubleshooting using meters	X	
7. LRU replacement general practices	X	X
<b>B – WIRING PRACTICES DOCUMENTATION</b> <b>Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual.</b>		
8. Standard wiring practices manual structure/overview	X	X
9. Chapter cross-reference index	X	X
10. Important data and tables	X	X
11. Wiring diagram manuals	X	X
12. Other documentation as applicable	X	X
<b>C – INSPECTION</b> <b>Know the different types of inspections, human factors in inspections, zonal areas and typical damages.</b>		
13. General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards	X	X
14. Human factors in inspection		X
15. Zonal areas of inspection		X
16. Wiring system damage	X	X
<b>D – HOUSEKEEPING</b> <b>Know the contamination sources, materials, cleaning and protection procedures.</b>		
17. Aeroplane external contamination sources	X	X
18. Aeroplane internal contamination sources	X	X
19. Other contamination sources	X	X
20. Contamination protection planning	X	
21. Protection during aeroplane maintenance and repair	X	
22. Cleaning processes	X	
<b>E – WIRE</b>		

<b>Know or demonstrate the correct identification of different wire types, their inspection criteria and damage tolerance, repair and preventative maintenance procedures.</b>		
23. Wire identification, type and construction	X	X
24. Insulation qualities and damage limits	X	X
25. Inspection criteria and standards for wire and wire bundles		X
26. Wire bundle installation practices	X	X
27. Typical damage and areas found (aeroplane specific)	X	X
28. Maintenance and repair procedures	X	X
29. Sleeving	X	X
30. Unused wires - termination and storage	X	X
31. Electrical bonding and grounds	X	X
<b>F – CONNECTIVE DEVICES</b> <b>Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane.</b>		
32. General connector types and identification	X	X
33. Cautions and protections	X	X
34. Visual inspection procedures	X	X
35. Typical damage found	X	X
36. Repair procedures	X	X
<b>G – CONNECTIVE DEVICE REPAIR</b> <b>Demonstrate the procedures for replacement of all parts of typical types of connectors found on the applicable aeroplane.</b>		
37. Circular connectors	X	
38. Rectangular connectors	X	
39. Terminal blocks - modular	X	
40. Terminal blocks - non-modular	X	
41. Grounding modules	X	
42. Pressure seals	X	



## Appendix B to AMC 20-22 – EWIS Minimum Initial Training Programme for Group 3 through 8

Target Group 3: Qualified staff performing electrical/avionic engineering on in-service aeroplane.

Target Group 4: Qualified staff performing general maintenance/inspections not involving wire maintenance (LRU change is not considered wire maintenance)

Target Group 5: Qualified staff performing other engineering or planning work on in-service aeroplane

Target Group 6: Other service staff with duties in proximity to electrical wiring interconnection systems

Target Group 7: Flight Deck Crew

Target Group 8: Cabin Crew

TARGET GROUPS	3	4	5	6	7	8
<b>A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES</b> <b>Know or demonstrate the safe handling of aeroplane electrical systems, line replaceable units (LRU), tooling, troubleshooting procedures, and electrical measurement.</b>						
1. Safety practices		X		X	X	X
2. Electrostatic discharge sensitive (ESDS) device handling and protection		X				
7. LRU replacement general practices		X				
<b>B – WIRING PRACTICES DOCUMENTATION</b> <b>Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or practices manual.</b>						
8. Standard wiring practices manual structure/overview	X					
9. Chapter cross-reference index	X					
10. Important data and tables	X					
11. Wiring diagram manuals	X					
12. Other documentation as applicable	X					
<b>C – INSPECTION</b> <b>Know the different types of inspections, human factors in inspections, zonal areas and typical damages.</b>						
13. General visual inspection (GVI), detailed inspection (DET), special detailed inspection (SDI), and zonal inspection, and their criteria and standards		X	X			
14. Human factors in inspection			X			
15. Zonal areas of inspection			X			

16.	Wiring system damage		X	X	Low level	Low level	Low level
<b>D – HOUSEKEEPING</b> <b>Know the contamination sources, materials, cleaning and protection procedures.</b>							
17.	Aeroplane external contamination sources		X		X	X	X
18.	Aeroplane internal contamination sources		X		X	X	X
19.	Other contamination sources		X		X	X	X
20.	Contamination protection planning	X	X	X			
21.	Protection during aeroplane maintenance and repair	X	X	X			
22.	Cleaning processes	X	X	X	X		
<b>E – WIRE</b> <b>Know or demonstrate the correct identification of different wire types, their inspection criteria and damage tolerance, repair and preventative maintenance procedures.</b>							
23.	Wire identification, type and construction	X					
24.	Insulation qualities and damage limits	X					
25.	Inspection criteria and standards of wire and wire bundles	X					
26.	Wire bundle installation practices	X					
27.	Typical damage and areas found (aeroplane specific)	X	X	X	Low level	Low level	Low level
28.	Maintenance and repair procedures	X					
29.	Sleeving	X					
30.	Unused wires - termination and storage	X					
31.	Electrical bonding and grounds	X	X Bon d	X			
<b>F – CONNECTIVE DEVICES</b> <b>Know or demonstrate the procedures to identify, inspect, and find the correct repair for typical types of connective devices found on the applicable aeroplane.</b>							
32.	General connector types and identification	X					
33.	Cautions and protections	X					
34.	Visual inspection procedures	X					
35.	Typical damage found	X					
36.	Repair procedures	X					

## **Appendix C to AMC 20-22 – Curriculum and Lessons Plan**

---

### **Electrical Wiring Interconnection System Curriculum**

#### **1 OVERVIEW**

This training is targeted at each person who performs aeroplane maintenance, inspections, alterations or repairs on EWIS and/or structure. After training, the person is able to properly evaluate the EWIS and effectively use the manufacturers Chapter 20 Wiring System overhaul manual for that aeroplane. The training programme must include: wiring system condition, applicable repair schemes, wiring modifications and ancillary repairs to wiring systems and components. All of the training components are integrated to maintain wiring system quality and airworthiness of the aeroplane.

#### **2 OBJECTIVES**

Depending on the modules taught, the person shows competency in the following skills:

- a. Know or demonstrate the safe handling of aeroplane electrical systems, Line Replaceable Units (LRU), tooling, troubleshooting procedures, and electrical measurement.
- b. Know or demonstrate the construction and navigation of the applicable aeroplane wiring system overhaul or wiring practices manual.
- c. Know the different types of inspections, human factors in inspections, zonal areas and typical damages.
- d. Know the contamination sources, materials, cleaning and protection procedures.
- e. Know or demonstrate the correct identification of different wire types, their inspection criteria, and damage tolerance, repair and preventative maintenance procedures.
- f. Know or demonstrate the procedures to identify, inspect and find the correct repair for typical types of connective devices found on the applicable aeroplane.
- g. Demonstrate the procedures for replacement of all parts of typical types of connective devices found on the applicable aeroplane.

#### **3 SCOPE**

The course is to be used by training providers for all maintenance persons at any stage in their careers. The person can be trained to the appropriate level using the applicable modules, depending on the person's experience, work assignment and operator's policy.

### **MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:**

- (1) Safety practices

- (2) ESDS device handling and protection
- (3) Tools, special tools and equipment
- (4) Verify calibration/certification of instruments, tools, and equipment
- (5) Required wiring checks using the Troubleshooting Procedures and charts
- (6) Measurement and troubleshooting using meters
- (7) LRU replacement general practices

**MODULE B – WIRING PRACTICES DOCUMENTATION:**

- (1) Chapter 20 structure/overview
- (2) Chapter 20 cross-reference index
- (3) Chapter 20 important data and tables
- (4) Wiring Diagram Manual
- (5) Other documentation (as applicable)

**MODULE C – INSPECTION:**

- (1) Special inspections
- (2) Criteria and standards
- (3) Human factors in inspection
- (4) Zonal areas of inspection
- (5) Wiring system damage

**MODULE D – HOUSEKEEPING:**

- (1) Aeroplane external contamination sources
- (2) Aeroplane internal contamination sources
- (3) Other contamination sources
- (4) Contamination protection planning
- (5) Protection during aeroplane maintenance and repair
- (6) Cleaning processes

**MODULE E – WIRE:**

- (1) Identification, type and construction
- (2) Insulation qualities
- (3) Inspection criteria and standards of wire and wire bundles
- (4) Wire bundle installation practices
- (5) Typical damage and areas found (aeroplane specific)
- (6) Maintenance and repair procedures
- (7) Sleeving

- (8) Unused wires - termination and storage
- (9) Electrical bonding and grounds

#### **MODULE F – CONNECTIVE DEVICES:**

- (1) General types and identification
- (2) Cautions and protections
- (3) Visual inspection procedures
- (4) Typical damage found
- (5) Repair procedures

#### **MODULE G – CONNECTIVE DEVICE REPAIR:**

- (1) Circular connectors
- (2) Rectangular connectors
- (3) Terminal blocks - modular
- (4) Terminal blocks - non-modular
- (5) Grounding modules
- (6) Pressure seals

### **MODULE A: GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICE**

#### **1 OVERVIEW**

Through Module A, the instructor lays the groundwork of safe, effective maintenance and repair of the aeroplane EWIS and LRU removal and replacement, including BITE test, without damage to the aeroplane or injury to the student.

The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

#### **2 OBJECTIVES**

After this module is complete, the student is able to demonstrate the following skills:

- a. Know the safety procedures of normal and non-normal maintenance procedures so that the person can protect himself/herself and the aeroplane.
- b. Recognise ESDS equipment and demonstrate standard anti-static procedures so that no damage occurs to that equipment.
- c. Demonstrate the correct use of hand tools including specialised and automated tools and equipment.
- d. Verify the calibration of electrical measuring instruments, tools and equipment so that correct maintenance procedures may be carried out.

- e. Demonstrate the process and procedures to successfully use the troubleshooting procedures and charts of current aeroplane faults and know re-occurring problems causing “No Fault Found” on removed LRU.
- f. Demonstrate the correct use of electrical meters for measuring voltage, current, resistance, continuity, insulation and short to ground.
- g. Know the removal and replacement techniques so that no damage will occur to the LRU or aeroplane connector.

### 3 STRATEGIES

Normal classroom lecture can be used for the majority of the training. The following strategies can be used to expedite learning and are recommended to the instructor:

ESDS handling and protection	Multimedia/training aids
Calibration/certification of instruments, tools, and equipment	Company policy
Wiring checks using the Troubleshooting Procedures and charts	Aeroplane manuals
Measurement and troubleshooting using meters	Meters and circuits
LRU removal and replacement	Aeroplane manuals

## MODULE A – GENERAL ELECTRICAL WIRING INTERCONNECTION SYSTEM PRACTICES:

- 1 Safety Practices
  - a. Current is lethal - First aid
  - b. Applying power to the aeroplane
  - c. Isolating the circuit
  - d. Aeroplane warnings
  - e. Human factors
- 2 ESDS Device Handling and Protection
  - a. Sources of electrostatic discharge
  - b. Soft and hard failures
  - c. ESDS safety procedures
  - d. ESDS handling/packing procedures
- 3 Tools, Special Tools and Equipment
  - a. General hand tools
  - b. Specialised tools
  - c. Automated tools and equipment
- 4 Verify Calibration/Certification of Instruments, Tools and Equipment
  - a. Tools requiring certification

- b. Determining certification requirements
  - c. Typical problems
- 5 Required Wiring Checks Using the Troubleshooting Procedures and charts
- a. Troubleshooting procedures manual (all chapters)
  - b. Aeroplane Maintenance Manual/Illustrated Parts Catalogue
  - c. Wiring schematics/troubleshooting graphics
  - d. Wiring diagrams
  - e. The process of troubleshooting
  - f. Testing of LRU connectors
  - g. Troubleshooting exercises
  - h. Company “No Fault Found” policy and data
- 6 Measurement and Troubleshooting Using Meters
- a. Voltage, current and resistance
  - b. Continuity
  - c. Insulation
  - d. Short to ground
  - e. Loop impedance
- 7 LRU Replacement - General Practices
- a. Different retention devices
  - b. Certification considerations (e.g. CAT 2/CAT3 Landing)
  - c. LRU re-racking procedures
  - d. “No Fault Found” data (aeroplane specific)
  - e. Built-in test equipment (BITE)

## **MODULE B: WIRING PRACTICES DOCUMENTATION**

### **1 OVERVIEW**

Through Module B, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane EWIS. The intent of this module is to teach the person how to locate desired information in the Chapter 20 Wiring System overhaul manual, Wiring Diagram Manual and other applicable documentation. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

### **2 OBJECTIVES**

After this module is complete, the person is able to demonstrate the following skills:

- a. Know the applicable Sub-Chapters and Section to follow during normal and non-normal electrical maintenance procedures.
- b. Demonstrate the use of the Cross-Reference Index, Chapter Table of Contents, and Subject Tables of Contents so as to find specific material within each Sub-Chapter and Section.
- c. Demonstrate the use of the associated tables for replacement of wire, connective devices and contacts, and associated components, including approved replacements.
- d. Demonstrate the use of the Wiring Diagram Manual.
- e. Demonstrate the use of other documentation (as applicable).

### **3 STRATEGIES**

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices Manual, Wiring Diagram Manual, and other applicable documentation should be made available to the class so that hands-on exploration of the material can be achieved.

## **MODULE B – WIRING PRACTICES DOCUMENTATION:**

- 1 Chapter 20 Structure/Overview
  - a. Table of contents
  - b. Sub-chapter titles
  - c. Section structure
  - d. General procedures
- 2 Chapter 20 Cross-Reference Index
  - a. Cross-reference index – Alphanumeric
  - b. Cross-reference index – Standard Part number
  - c. Cross-reference index – Suppliers
  - e. Equivalence tables – Std Part Numbers EN-ASN-NSA
- 3 Chapter 20 Important Data and Tables
  - a. Contact crimp tools, insertion/extraction tools
  - b. Wire Insulation removal tools
  - c. Electrical cable binding
  - d. Wire type codes and part numbers identification
  - e. Connective devices types and contacts
  - f. Terminal blocks and terminations
  - g. Terminal blocks modules, grounding modules and contacts



- h. Cleaning procedures
- i. Repair procedures
- 4 Wiring Diagram Manual (WDM)
  - a. Front matter
  - b. Diagrams
  - c. Charts
  - d. Lists
- 5 Other documentation (as applicable)

## **MODULE C: INSPECTION**

### **1 OVERVIEW**

Through Module C, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane wiring systems, by teaching the skills of inspection so as to identify wiring system damage. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

### **2 OBJECTIVES**

After this module is complete, the person is able to demonstrate the following skills:

- a. Know the different types of inspections: General Visual Inspection (GVI), Detailed Inspection (DET), Zonal Inspection and Enhanced Zonal Analysis Procedure (EZAP).
- b. Know the criteria and standards of inspection so that the person knows which tools are used to ensure inspection procedures and standards are achieved, which leads to all defects being found.
- c. Know the effects of fatigue and complacency during inspection and how to combat these effects (Human Factors).
- d. Know the specific zonal inspection requirements related to system affiliation and environmental conditions.
- e. Recognise typical wiring system damage, such as hot gas, fluid contamination, external mechanically induced damage, chafing, corrosion, signs of overheating of wire, wire bundles, connective and control device assemblies.

### **3 STRATEGIES**

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual wiring system damage could be used to show typical problems found on the aeroplane. Examples of discrepancies should be made available to the student. [AMC 20-21](#), Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

## **MODULE C – INSPECTION**

1. Special Inspections
  - a. General Visual Inspection (GVI)
  - b. Detailed Inspection (DET)
  - c. Zonal Inspection
  - d. Enhanced Zonal Analysis Procedure (EZAP)
2. Criteria and Standards
  - a. Tools
  - b. Criteria/standards
  - c. Procedures of inspection
3. Human Factors in Inspection
  - a. Fatigue
  - b. Complacency
4. Zonal Areas of Inspection
  - a. Zonal areas of inspection
  - b. Zonal inspection procedures and standards
5. Wiring System Damage
  - a. Swarf/FOD/metal shavings
  - b. External mechanically induced damage
  - c. Hot gas
  - d. Fluid contamination
  - e. Vibration/chafing
  - f. Corrosion
  - g. Signs of overheating

## **MODULE D: HOUSEKEEPING**

### **1 OVERVIEW**

Through Module D, the instructor lays the groundwork for safe, effective maintenance and repair of aeroplane EWIS, by teaching housekeeping strategies, so as to keep the EWIS free of contamination. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

### **2 OBJECTIVES**

After this module is complete, the person is able to demonstrate the following skills:

- a. Recognise external contamination and other damage due to external environmental conditions.
- b. Know the aeroplane internal contamination sources so that inspection processes can be effectively carried out and contamination damage easily recognised.
- c. Recognise other possible contamination sources.
- d. Know the planning procedures to be followed, on EWIS areas in different parts of the aeroplane.
- e. Know the protection procedures and processes to protect the EWIS during maintenance and repair.
- f. Know the process of cleaning wiring systems during maintenance and repair.

### **3 STRATEGIES**

Normal classroom lecture can be used for the majority of the training. ATA 117 video and colour photos of actual EWIS contamination could be used to show typical problems found on the aeroplane. Relevant Aeroplane Maintenance Manual and/or Chapter 20 Wiring Practices procedures should be used. The ATSRAC Task Group 1, Non-Intrusive Inspection Final Report could be used to identify typical housekeeping issues. [AMC 20-21](#), Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

## **MODULE D - HOUSEKEEPING**

- 1 Aeroplane External Contamination Sources
  - a. De-ice fluids
  - b. Water and rain
  - c. Snow and ice
  - d. Miscellaneous (e.g. cargo/beverage spillage)
  - e. Air erosion
- 2 Aeroplane Internal Contamination Sources
  - a. Hydraulic oils
  - b. Engine and APU oils
  - c. Fuel
  - d. Greases
  - e. Galleys and toilets
  - f. Lint/Dust

- g. Bleed air and hot areas
- h. Hazardous materials
- 3 Other Contamination Sources
  - a. Paint
  - b. Corrosion inhibitor
  - c. Drill shavings/Swarf
  - d. Foreign objects (screws, washers, rivets, tools, etc.)
  - e. Animal waste
- 4 Contamination Protection Planning
  - a. Have a plan/types of plan/area mapping
  - b. Protection and Caution Recommendations
  - c. Procedures
  - d. Keep cleaning
- 5 Protection during Aeroplane Maintenance and Repair
  - a. Recommended general maintenance protection procedures
  - b. Recommended airframe repair protection procedures
  - c. Recommended powerplant repair protection procedures
- 6 Cleaning Processes
  - a. Fluid contamination
    - (1) Snow and ice
    - (2) De-ice fluid
    - (3) Cargo spillage
    - (4) Water and rain
    - (5) Galleys
    - (6) Toilets water waste
    - (7) Oils and greases
    - (8) Pressure washing
  - b. Solid contamination
    - (1) Drill shavings/Swarf
    - (2) Foreign objects (screws, washers, rivets, tools, etc.)
  - c. Environmental contamination
    - (1) Lint and dust
    - (2) Paint

- (3) Corrosion inhibitor
- (4) Animal waste

## **MODULE E: WIRE**

### **1 OVERVIEW**

Through Module E, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS by teaching wire selection and inspection strategies. The Instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

### **2 OBJECTIVES**

After this module is complete, the person is able to demonstrate the following skills:

- a. Demonstrate the procedure used to identify specific wire types using the aeroplane manuals.
- b. Know from approved data different insulation types and their relative qualities.
- c. Know the inspection criteria for wire and wire bundles.
- d. Know the standard installation practices for wire and wire bundles (aeroplane specific).
- e. Know typical damage that can be found (aeroplane specific).
- f. Demonstrate the repair procedures for typical damage found on the student's type of aeroplane.
- g. Demonstrate the procedures to fitting differing types of sleeving (aeroplane specific).
- h. Know the procedures for termination and storage of unused wires.
- i. Know the correct installation practices for electrical bonds and grounds (aeroplane specific).

### **3 STRATEGIES**

Normal classroom lecture can be used for the majority of the training with hands-on practice for Section 6. Chapter 20 Wiring Practices, Wiring Diagram Manual and WDM Lists should be made available to the class to ensure hands-on use of the manual so that wire identification, inspection, installation and repair procedures can be fully explored. Examples of wire discrepancies should be made available to the student. The ATSRAC Task Group 1, Intrusive Inspection Final Report could be used to identify typical wire issues. [AMC 20-21](#), Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

## **MODULE E – WIRE**

- 1 Identification, Type and Construction
  - a. Wire type codes – alphanumeric
  - b. Wire type codes – specification and standard part number
  - c. Wire type codes – specified wire and alternate
  - d. Manufacturer identification
- 2 Insulation Qualities
  - a. Types of insulation
  - b. Typical insulation damage and limitations
  - c. Carbon arcing
- 3 Inspection Criteria and Standards of Wire and Wire Bundles
  - a. Inspection of individual wiring
  - b. Inspection of wire bundles
- 4 Wire Bundle Installation Practices
  - a. Routing
  - b. Segregation rules
  - c. Clearance
  - d. Clamp inspection
  - e. Clamp removal and fitting
  - f. Conduit types and fitting
  - g. Raceways
  - h. Heat shields and drip shields
- 5 Typical Damage and Areas Found (aeroplane specific)
  - a. Vibration
  - b. Heat
  - c. Corrosion
  - d. Contamination
  - e. Personnel traffic passage
- 6 Maintenance and Repair Procedures
  - a. Wire damage assessment and classification
  - b. Approved repairs - improper repairs
  - c. Shielded wire repair
  - d. Repair techniques

- e. Terminals and splices
  - f. Preventative maintenance procedures
- 7 Sleeving
- a. Identification sleeves
  - b. Shrink sleeves
  - c. Screen braid grounding crimp sleeves
  - d. Screen braid grounding solder sleeves
- 8 Unused Wires - Termination and Storage
- a. Termination – end caps
  - b. Storage and attachment
- 9 Electrical Bonding and Grounds
- a. Inspection standards
  - b. Primary Bonding (HIRF protection)
  - c. Secondary Bonding (System grounding)
  - d. Lightning strikes

## **MODULE F: CONNECTIVE DEVICES**

### **1 OVERVIEW**

Through Module F, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS by teaching the identification, inspection and repair of connective devices found on the aeroplane. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

### **2 OBJECTIVES**

After this module is complete, the person is able to demonstrate the following skills:

- a. Know the general types and positive identification of connective devices (aeroplane specific).
- b. Know the various safety procedures, cautions and warnings prior to inspection.
- c. Know the relevant visual inspection procedures for each type of connector so that any internal or external damage can be found.
- d. Recognise typical external and internal damage to the connector.
- e. Demonstrate where to find the relevant repair schemes from Chapter 20 for connector repair.

### **3 STRATEGIES**

Normal classroom lecture can be used for the majority of the training. The Chapter 20 Wiring Practices manual should be made available to the class so that hands-on use of the manual can be ensured. Connector identification, inspection and repair procedures should be fully explored. Colour photographs of typical external damage and internal damage could be used to show problems on the aeroplane. The ATSRAC Task Group 1, Non-Intrusive Inspection and Intrusive Inspection Final Report, Chapter 7, could be used to identify typical connector issues. [AMC 20-21](#), Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

## **MODULE F – CONNECTIVE DEVICES**

- 1 General Types and Identification
  - a. Part number identification
  - b. Reference tables
  - c. Specific connective devices chapters
- 2 Cautions and Protections
  - a. Safety precautions
  - b. Maintenance precautions
- 3 Visual Inspection Procedures
  - a. Installed inspection criteria
  - b. Removed inspection criteria
- 4 Typical Damage Found
  - a. Exterior damage
  - b. Internal damage
- 5 Repair Procedures
  - a. Finding the correct section
  - b. Finding the correct part
  - c. Finding the correct tooling
  - d. Confirming the correct repair

## **MODULE G: CONNECTIVE DEVICES REPAIR**

### **1 OVERVIEW**

Through Module G, the instructor lays the groundwork for safe, effective maintenance, alteration and repair of aeroplane EWIS. This module is primarily a hands-on class, emphasising the repair and replacement of connective devices found on the aeroplane. This list can be used to cover typical connectors for



aeroplanes and can be adjusted to suit training requirements. The instructor may vary the depth and scope of the topics to be covered, depending on the type of aeroplane to be maintained and skills of the persons.

## 2 OBJECTIVE

After this module is complete, the person will have the following skills:

- a. Demonstrate the replacement of components for circular connectors.
- b. Demonstrate the replacement of components for rectangular connectors.
- c. Demonstrate the replacement of components for terminal blocks - modular.
- d. Demonstrate the replacement of components for terminal blocks - non-modular.
- e. Demonstrate the replacement of components for grounding modules.
- f. Demonstrate the replacement of pressure seals.

## 3 STRATEGIES

This class is primarily a hands-on class to give the student motor skills in the repair of connective devices from their aeroplane. The Chapter 20 Wiring Practices Manual and the appropriate connective devices should be made available to the class so that repair procedures can be fully explored. Photographs of typical internal conditions and external damage could be made available. It is recommended that MODULE F: CONNECTORS should precede this module. [AMC 20-21](#), Programme to Enhance Aeroplane EWIS Maintenance is recommended as a source of typical aeroplane wiring installations and areas of concern.

## MODULE G – CONNECTIVE DEVICES REPAIR

- 1 Circular Connectors
  - a. Disassembly
  - b. Back-shell maintenance
  - c. Contact extraction and insertion
  - d. Contact crimping
  - e. Assembly and strain relief
- 2 Rectangular Connectors
  - a. Disassembly
  - b. Back-shell maintenance
  - c. Contact extraction and insertion
  - d. Contact Crimping
  - e. Assembly and strain relief
- 3 Terminal Blocks - Modular

- a. Disassembly
  - b. Contact extraction and insertion
  - c. Contact Crimping
  - d. Assembly and strain relief
- 4 Terminal Block – Non-modular
- a. Disassembly
  - b. Terminal Lug Crimping
  - c. Terminal Lug Stacking
  - d. Assembly, torque and strain relief
- 5 Grounding Modules
- a. Disassembly
  - b. Contact extraction and insertion
  - c. Contact Crimping
  - d. Assembly and strain relief
- 6 Pressure Seals
- a. Disassembly
  - b. Maintenance
  - c. Assembly and strain relief

## AMC 20-24

### **AMC 20-24 Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHz Extended Squitter.**

---

#### **1 PREAMBLE**

- 1.1 The scope of this Acceptable Means of Compliance (AMC) is the airworthiness and operational approval of the “Enhanced Air Traffic Services in Non-Radar Areas using ADS-B Surveillance” (ADS-B-NRA) application.
- 1.2 Operational benefits of the ADS-B-NRA application include the enhancement of the Air Traffic Control Service in current non-radar airspace. ADS-B-NRA would provide controllers with improved situational awareness of aircraft positions, and in consequence appropriate separation minima could be applied depending on the environment and the approval of the CAA. Current non-radar airspace is controlled using procedural methods which demand large separations. ADS-B-NRA separation minima would be smaller than that used in current non-radar airspace. Alerting Services in nonradar airspace will be enhanced by more accurate information on the latest position of aircraft.  
  
Hence, it is expected that in areas where radar coverage is not feasible or not economically justified this application will provide benefits to capacity, efficiency and safety in a way similar to what would be achieved by use of SSR radar.
- 1.3 (Reserved).
- 1.4 It is assumed the aircraft uses the globally interoperable 1090 MHz Extended Squitter (ES) data link technology, compliant with ICAO SARPS in Annex 10 and in line with the recommendations of the Conference ICAO ANC-11.
- 1.5 It is assumed that aircraft will be interoperable with all implementation programmes using the EUROCAE/RTCA ADS-B-NRA standard (ED126, DO-303).
- 1.6 The meaning of abbreviations may be found in [Appendix 1](#).

#### **2 PURPOSE**

- 2.1 This AMC is for operators seeking to operate in airspace classifications A to E where ADS-B-NRA services have been implemented by the Air Navigation Service Provider. It provides the basis for approval of aircraft systems and identifies operational considerations.

It may also assist other stakeholders by alerting them to aircraft requirements, operator procedures and related assumptions. These other stakeholders could include airspace planners, air traffic service providers, ATS system manufacturers, surveillance data processing system manufacturers,

communication service providers, aircraft and avionics equipment manufacturers and ATS regulatory authorities.

- 2.2 Acceptable Means of Compliance (AMC) illustrate a means, but not the only means, by which a requirement contained in an airworthiness code or an implementing rule, can be met.

An applicant correctly implementing this AMC in its entirety is assured of acceptance of compliance with the airworthiness considerations prior to use of the automatic dependent surveillance broadcast equipment. The operational considerations in this AMC are consistent with the operational considerations in the position paper 039 revision 8, that is endorsed by the JAA Operations Sectorial Team (OST).

### 3 SCOPE

- 3.1 This AMC is applicable to the various ATS services contained in the ADS-B-NRA application, including separation services. This AMC fulfils the ADS-B-NRA Safety, Performance Requirements and Interoperability Requirements as established in EUROCAE ED-126<sup>1</sup>, using the methodology described in EUROCAE document ED-78A<sup>2</sup>.

AMC requirements are driven by the ED-126 requirements for a 5NM separation service (applicable to both en-route and TMA airspace).

Note: the actual choice of ADS-B-NRA ATC service provision, including of the applicable separation minima, is at the discretion of the implementing Air Traffic Service Provider, and should be based on local safety cases.

- 3.2 The AMC addresses the 1090 MHz Extended Squitter (ES) data link technology as the ADS-B transmit technology.<sup>3</sup>

### 4 REFERENCE DOCUMENTS

#### 4.1 Related Regulatory Requirements

- EASA CS/FAR 25.1301, 25.1307, 25.1309, 25.1322, 25.1431, 25.1581, or equivalent requirements of CS 23, 27 and 29, if applicable.
- MCAR-Air Operations ORO.GEN.160, CAT.OP.MPA.125, CAT.OPA.MPA.175, CAT.IDE.A.100, CAT.IDE.A.105 and ORO.MLR.100.
- MCAR-11

#### 4.2 Related EASA/JAA TGL/NPA/AMC (and FAA TSO) Material

---

<sup>1</sup> ED-126: "Safety, Performance and Interoperability Requirements Document for ADS-B-NRA" Application

<sup>2</sup> ED-78A: Guidelines for approval of the provision and use of Air Traffic Services supported by Data communications

<sup>3</sup> Other, requirements compliant, ADS-B transmit systems (e.g. VDL Mode 4) are expected to be covered through separate regulatory material, as appropriate.

- ETSO-2C112b: Minimum Operational Performance Specification for SSR Mode S Transponders (adopts ED-73B)
- ETSO-129A (TSO-129/TSO-129A): Airborne Supplemental Navigation Equipment Using the Global Positioning System (GPS)
- ETSO-145/ETSO-146 (TSO-145/TSO-146; TSO-145A/TSO-146A): Airborne Navigation Sensors Using the Global Positioning System (GPS) Augmented by the Wide Area Augmentation System (WAAS)
- AMC 20-13 Certification of Mode S Transponder Systems for Enhanced Surveillance
- JAA Temporary Guidance leaflet (TGL) 13, Revision 1: Certification of Mode S Transponder Systems for Elementary Surveillance

#### 4.3 Related FAA Advisory Circular Material

- FAA AC20-138A: Airworthiness Approval of Global Navigation Satellite System (GNSS) Equipment

#### 4.4 Related EUROCAE/RTCA Standards

- ED-126 (DO-303): Safety, Performance and Interoperability Requirements Document for ADS-B-NRA Application (December 2006)
- ED78A (DO-264): Guidelines for Approval of the Provision and Use of Air Traffic Services Supported by data communications;
- ED-102 (DO-260): MOPS for 1090MHz for ADS-B
- DO-260A: MOPS for 1090MHz for ADS-B
- ED-73B (DO-181C): Minimum Operational Performance Specification for Secondary Surveillance Radar Mode S Transponders
- ED-26: MPS for airborne altitude measurements and coding systems

#### 4.5 Related ICAO Standards and Manuals

- PANS-ATM, Doc 4444, Amendment 4: Procedures for Air Navigation Services – Air Traffic Management
- Annex 10 (Volume III & IV): Aeronautical Telecommunications

## 5 ASSUMPTIONS

Applicants should note that this AMC is based on the following assumptions.

### 5.1 Air Traffic Service Provider (ATSP)

ATSP implements the ADS-B-NRA application compliant with relevant requirements of the safety, performance and interoperability requirements of EUROCAE standard ED-126. Deviations from, or supplements to the established standards are assessed by the ATSP. Deviations that potentially impact the airborne domain should be assessed in coordination with relevant stakeholders as per ED78A.

Section 8 of this document, "Airworthiness Considerations", lists permissible deviations from the target requirements related to the use of existing aircraft installations in support of initial implementations<sup>1</sup>. These deviations are currently considered operationally acceptable under the assumption that ground mitigation means as discussed in the following subsections, are implemented, at the discretion of the ATSP.

#### 5.1.1 Consistency of position quality indicators with associated position information at time of transmission

In cases where position quality indicators are not consistent with actual position quality (e.g., due to uncompensated latency in position transmissions), the implementing ATSP might:

- treat the higher quality indicator encodings as an advised lower one (e.g. NUC=7 may be treated as NUC=5) or,
- consider, for separation purpose, a quality indicator more stringent than the one stated in ED-126 (e.g. NUC =5 rather than NUC=4).

#### 5.1.2 Encoding of NUC Quality Indicator (DO-260 compliant transponders)

In order to mitigate the encoding of the NUC quality indicator based on accuracy quality information (HFOM) in the case of the unavailability of the GPS RAIM function (i.e. unavailability of HPL information), the implementing ATSP may, for instance, rely on the analysis of the frequency and duration of the unavailability of the RAIM function (as part of the local safety assessment).

#### 5.1.3 Transmission of generic emergency indicator only

In order to mitigate the transmission of only the generic emergency indicator (and not also the discrete codes selected by the flight crew), It is assumed that appropriate operational procedures have been established by the implementing ATSP and that pilots and controllers have been trained in their use.

#### 5.1.4 Communications Service Provider (CSP)

In case of CSPs providing (part of) the ground surveillance data communication services (operation of ADS-B ground stations and/or surveillance data networks), the CSP is committed to provide communication services to ATSPs with the expected Quality of Service as defined in a specific Service Level Agreement.

The Service Level Agreement is bilaterally agreed between the CSP and an ATSP. The terms of reference of the Service Level Agreement are consistent with the performance requirements of the ED-126 document.

## 5.2 Aeronautical Information Service

---

<sup>1</sup> Refer to sections 8.3.3, 8.3.5 and 8.8.2.

Each State publishes in its AIP/NOTAM, or equivalent notification, information related to the surveillance provisions, schedule, relevant procedures and confirmation of compliance with ED-126.

## 6 SYSTEM DESCRIPTION

The basic concept of ADS-B involves the broadcasting of surveillance information from aircraft via a data link.

To support the ADS-B-NRA application, the overall ADS-B avionics system (in the following referred to as “ADS-B System”) would need to provide the following functions:

- Adequate surveillance data provision capability;
- ADS-B message processing (encoding and generation);
- ADS-B message transmission (1090 MHz ES airborne surveillance data-link);

Whereas the latter two functions are incorporated in the 1090 MHz ES ADS-B transmit system, the surveillance data provision is realised through various on-board surveillance data sources (e.g. horizontal position source, barometric altimetry, ATC transponder control panel).

The horizontal position accuracy and integrity requirements of the ADS-B-NRA application are associated with quality indicators which form part of the air-to-ground ADS-B message exchange. The interconnecting avionics architecture is part of the ADS-B System.

## 7 FUNCTIONAL CRITERIA

Note: ICAO and EUROCAE/RTCA interoperability references, including aspects of range and resolution of the various data items listed hereafter, for both ED-102/DO-260 and DO-260A equipment-based ADS-B transmit systems, are presented in [Appendix 4](#).

7.1 In line with ED-126 (section 4), the ADS-B System needs to meet the following surveillance data transmission requirements, as a minimum:

- A unique ICAO 24 bit aircraft address (contained within each ADS-B message transmission);
- Horizontal Position (latitude and longitude);
- Horizontal Position Quality Indicator(s) (position integrity for both ED-102/DO-260 and DO-260A based ADS-B transmit systems, as well as accuracy for DO-260A based ADS-B transmit systems);
- Barometric Altitude;
- Aircraft Identification;
- Special Position Identification (SPI);

- Emergency Status and Emergency Indicator;
  - Version Number (in aircraft operational status message, if avionics are DO-260A compliant).
- 7.2 In line with ED-126 (section 4), it is recommended that the ADS-B System meets the following optional surveillance data transmission requirement:
- Ground Velocity.

## 8 AIRWORTHINESS CONSIDERATIONS

### 8.1 Airworthiness Certification Objectives

For the purposes of the ADS-B-NRA application, the ADS-B System installed in the aircraft needs to be designed to deliver data that satisfy the airborne domain requirements in line with ED-126 Section 3.4, ([Appendix 3](#) provides a summary for information purposes).

### 8.2 ADS-B System

8.2.1 The (overall) ADS-B System integrity level with respect to the processing of horizontal position data and horizontal position quality indicators, covering the processing (and data exchange) chain from horizontal position data source(s) to ADS-B transmit data string encoding) needs to be 10-5/fh (refer also to Table 1 in [Appendix 3](#)).

*Note 1: this integrity level is required to adequately protect against the corruption of horizontal position data and horizontal position quality indicators when applying separation.*

*Note 2: These performance figures have been set for the “ADS-B out” function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126.*

*Note 3: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved.*

*Note 4: Also refer to § 3.1.*

8.2.2 The (overall) ADS-B System continuity level needs to be  $2 \times 10^{-4}$ /fh (refer also to Table 1 in [Appendix 3](#)).

*Note 1: These performance figures have been set for the “ADS-B out” function, to be used in ADS-B NRA operations as laid down by the Operational Safety Assessment in Annex C of ED 126;*

*Note 2: Compliance with these performance figures do not constitute per se a demonstration that the safety objectives of ADS-B NRA operations allocated to avionics are achieved;*

*Note 3: Also refer to § 3.1.*



8.2.3 The latency of the horizontal position data, including any uncompensated latency, introduced by the (overall) ADS-B System does not exceed 1.5 second in 95% and 3 seconds in 99.9% of all ADS-B message transmission cases (refer also to Table 1 in [Appendix 3](#)).

### 8.3 ADS-B Transmit System

8.3.1 Compliance with the air-ground interoperability requirements, as specified in ED-126 and presented in Section 7.1 and [Appendix 4](#), needs to be demonstrated.

8.3.2. For 1090 MHz Extended Squitter ADS-B transmit systems, this should be demonstrated by the relevant tests documented in:

- ED-73B/ETSO-2C112b (or DO-181C);
- ED-102, as a minimum, or an equivalent standard which is acceptable to the Agency (e.g. DO-260 or DO-260A).

8.3.3 ADS-B transmit systems need to transmit horizontal position quality indicators consistent with the associated position information at the time of transmission.

For the expression of the position accuracy quality, the related indicator should therefore reflect:

- The quality (in terms of both integrity and accuracy) of the position measurement itself; and
- Any (uncompensated) latency incurring prior to transmission.

Note: guidance on the quality indicators is provided in [Appendix 4](#).

The applicant needs to demonstrate the correctness of consistent quality indicator encodings in line with (minimum) position source quality and any (uncompensated) maximum latency as expressed in 8.2.3.

#### Permissible deviation for initial implementations:

For initial implementations, some aircraft installations may not take into account any (uncompensated) latency in the encoding of the position accuracy quality indicator as applicable at the time of transmission. Hence, such installations might transmit horizontal position quality indicators that are consistent with the associated position information only for lower quality indicator encodings<sup>1</sup> (e.g. NUC=5 or NAC=5) but not higher ones (e.g. NUC=7 or NAC=7). Such deviation from the above target

---

<sup>1</sup> This is a consequence of the definition of the quality indicator encoding describing an interval of values between a lower and an upper bound (refer also to Appendix 4.2). For instance, a NUC=5 encoding expresses an upper bound of position accuracy quality indication of 0.3NM whilst a NUC=7 encoding expresses an upper bound of 0.05NM. Therefore, in case of e.g. the actual GNSS position source performance, a NUC=5 encoding provides sufficient margin to also correctly express the effects of on-board uncompensated latency whilst this is not the case for a NUC=7 encoding any more.

requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

- 8.3.4 The value of the horizontal position quality indicators need to be based on the integrity information for the encoding of the ED-102/DO-260 related NUC and the DO-260A related NIC quality indicator, as related to the horizontal position sources.

In addition, the encoding of the DO-260A NAC quality indicator needs to be based on the accuracy information of the horizontal position sources.

- 8.3.5 In case of ED-102/DO-260 based ADS-B transmit systems, the NUC Quality Indicator value need to be encoded based on the integrity containment radius<sup>1</sup> only.

Permissible deviation for initial implementations:

For initial implementations, some GNSS position source based aircraft installations may encode the NUC Quality Indicator on accuracy quality information (HFOM) under rare satellite constellation circumstances leading to the temporary unavailability of the integrity monitoring (RAIM) function (i.e. unavailability of integrity containment radius calculation). Such deviation from the above target requirement need to be listed in the Aircraft Flight Manual (refer to Section 9.3).

- 8.3.6 If the ADS-B transmit system does not have a means to determine an appropriate integrity containment radius and a valid position is reported, then the Quality Indicator (i.e. NUC or NIC) need to be encoded to indicate that the integrity containment radius is unknown (i.e. NUC/NIC should be set to 'zero').

- 8.3.7 Transmitter antenna installation needs to comply with guidance for installation of ATC transponders to ensure satisfactory functioning. (Also refer to ED-73B)

- 8.3.8 If more than one ADS-B transmit system is installed, simultaneous operation of both transmit systems needs to be prevented.

#### 8.4 Horizontal Position Data Sources

- 8.4.1 The requirements on horizontal position data sources are based on the ED-126 safety and performance assessments.

- 8.4.2 Components of horizontal position data sources external to the aircraft ADS-B system (such as the GNSS space segment) fall outside these airworthiness considerations. Such external components are assumed to operate in accordance with their specified nominal performance<sup>2</sup>.

---

<sup>1</sup> I.e. GNSS conformant HPL/HIL information.

<sup>2</sup> For GNSS based systems, this includes satellite constellation aspects.

Nevertheless, failures of the external data source components are required to be detected through on-board monitoring (as expressed in section 8.4.3).

8.4.3 Any eligible horizontal position data source needs to meet the following minimum requirements (refer also to Table 2 in [Appendix 3](#)):

- Correct encoding of quality indicator information in line with the actual performance of the selected horizontal position data source(s), i.e. in relation to position integrity containment bound (ED-102/DO-260 and DO-260A ADS-B transmit systems) and position accuracy (DO-260A ADS-B transmit systems);
- Position source failure probability:  $10^{-4}$  per hour<sup>1</sup>;
- Position integrity alert failure probability, commensurate with the performance characteristics of GNSS integrity monitoring<sup>2</sup>:  $10^{-3}$  (per position source failure event);
- Position integrity time to alert: 10 seconds.

8.4.4 If available and valid, integrity containment radius information should be provided to the ADS-B transmit system from the position data source, or equivalent, on the same interface as and together with each positional data.

8.4.5 If the integrity containment radius is not provided by the horizontal position data source, the ADS-B transmit system may use other means to establish an appropriate integrity containment radius<sup>3</sup>, provided a requirements compliant integrity alert mechanism is available.

8.4.6 Use of GNSS Systems as Primary Position Data Source

8.4.6.1 GNSS is considered as primary horizontal position data source for the provision of an acceptable accuracy and integrity performance in support of the ATC separation services contained within the ADS-B-NRA application.

The ED-126 safety and performance assessments are based on the specified performance and characteristics of GNSS systems, including receiver autonomous integrity monitoring. Therefore, for GNSS systems as specified in section 8.4.6.2, a safety and performance demonstration is not required.

---

<sup>1</sup> For GNSS based position sources, the failure occurs outside the aircraft system and is therefore expressed as per ATSU-hour. Proof of compliance of alternative solely aircraft based sources should take this into account and might have to express the requirement as  $10^{-5}$  per flight hour (i.e. for the en-route environment).

<sup>2</sup> As realised through receiver autonomous integrity monitoring (RAIM), including its characteristics of increasingly less likely to fail for position errors beyond the horizontal protection limit. Within ED-126, the position source failure is modelled as a bias error that equals the integrity containment radius.

<sup>3</sup> E.g. HPL/HIL based upon known RAIM protection threshold.

8.4.6.2 If GNSS is used as a positional source, the GNSS system should be either compatible with:

- ETSO C-129A, TSO C-129 or TSO C-129A; or
- ETSO C-145/C-146 or TSO C-145A/C-146A,

capable of delivering position data with a periodic interval of at least 1.2 s<sup>1</sup>.

8.4.6.3 For GNSS systems compatible with (E)TSO C-129 (any revision), it is highly desired that the system incorporates Fault Detection and Exclusion capability as defined in AC 20-138A, Appendix 1, "GPS as a Primary Means of Navigation for Oceanic/Remote Operations".

#### 8.4.7 Use of Alternative Compliant Position Data Sources

As the ED-126 safety and performance assessments are based on the performance and characteristics of GNSS systems, for alternative position sources a dedicated safety and performance assessment is required to demonstrate compliance with the ED-126 requirements.

#### 8.4.8 Use of Temporary Back-up Position Data Sources

Back-up position data sources not complying with the requirements referred to in section 8.4.3 may prove very useful in enhancing the continuity of ADS-B surveillance provision during temporary outages of the primary (or equivalent alternative) position data sources.

Any such back-up position data source needs to report its accuracy and integrity performance to the ADS-B transmit system, in a format compliant with ED-102/DO-260 or DO-260A, as appropriate.

### 8.5 Barometric Altitude Data Sources

8.5.1 Pressure altitude provided to the ADS-B transmit system needs to be in accordance with existing requirements for ATC transponders.

8.5.2 The digitizer code selected needs to correspond to within plus or minus 38.1 m (125 ft), on a 95% probability basis, with the pressure-altitude information (referenced to the standard pressure setting of 1013.25 hectopascals), used on board the aircraft to adhere to the assigned flight profile. (ICAO Annex 10, Vol IV, 3.1.1.7.12.2.4. See also EUROCAE ED-26).

The performance of the encoders and of the sensors needs to be independent from the pressure setting selected.

8.5.3 The transponder should indicate correctly the altitude resolution (quantisation) used, i.e. 25ft (from an appropriate source, default

---

<sup>1</sup> ETSO C-145/C146 provides additional capabilities compared with ETSO C129A such as: processing of GPS without Selective Availability, processing of SBAS signals when available and Fault Detection Exclusion as a basic function. Therefore ETSO C145/146 usually provides higher quality integrity values than ETSO C-129A equipment.

resolution) or 100ft (Gillham's coded source, permissible alternative resolution).

The conversion of Gillham's coded data to another format before inputting to the transponder is not permitted unless failure detection<sup>1</sup> can be provided and the resolution (quantisation) is set in the transmitted data to indicate 100ft.

8.5.4 In case more stringent barometric altimetry requirements are applicable in line with e.g. airspace requirements (e.g. RVSM) or other function requirements (e.g. ACAS II), then these requirements and their related regulation take precedence.

## 8.6 Aircraft Identification

8.6.1 Identification needs to be provided to the ADS-B transmit system so that the information is identical to the filed ICAO flight plan. This information may be provided from:

- A flight management system; or
- A pilot control panel; or
- For aircraft, which always operate with the same flight identification (e.g. using registration as the flight identification) it may be programmed into equipment at installation.

8.6.2 In case no ICAO flight plan is filed, the Aircraft Registration needs to be provided to the ADS-B transmit system.

## 8.7 Special Position Identification (SPI)

For ATC transponder-based ADS-B transmit systems, the SPI capability needs to be provided. The SPI capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

## 8.8 Emergency Status/Emergency Indicator

8.8.1 When an emergency status (i.e. discrete emergency code) has been selected by the flight crew, the emergency indicator needs to be set by the ADS-B transmit system.

8.8.2 For ATC transponder-based ADS-B transmit systems, the discrete emergency code declaration capability should be integrated into the transponder functionality and should be controlled from the transponder control panel.

### Permissible deviation for initial implementations:

For initial implementations, instead of the required transmission of the discrete emergency codes 7500, 7600 and 7700 when selected by the flight crew, the transmission of only the generic emergency indicator can

---

<sup>1</sup> For instance, this need can be satisfied by means of dual independent altitude corrected sensors together with an altitude data comparator (which may be incorporated and enabled in the ADS-B transmit system).

satisfy this requirement. Such deviation from the above target requirement needs to be listed in the Aircraft Flight Manual (refer to Section 9.3).

## 8.9 Airworthiness Considerations regarding Optional Provisions

### 8.9.1 Ground Velocity (OPTIONAL)

Ground velocity, e.g. from an approved GNSS receiver, in the form of East/West and North/South Velocity (including a velocity quality indicator) is recommended to be provided.

### 8.9.2 Special Position Identification (SPI) (OPTIONAL)

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to trigger the SPI indication.

### 8.9.3 Emergency Status/Emergency Indicator (OPTIONAL)

For non-ATC transponder-based ADS-B transmit systems (i.e. installations based on dedicated ADS-B transmitters), a discrete input or a control panel should be provided to indicate the emergency status (discrete emergency code).

### 8.9.4 Flight Deck Control Capabilities (OPTIONAL)

8.9.4.1 Means should be provided to the flight crew to modify the Aircraft Identification information when airborne.

8.9.4.2 Means should be provided to the flight crew to disable the ADS-B function on instruction from ATC without disabling the operation of the ATC transponder function.

*Note: It is recommended to implement an independent ADS-B disabling function. For future ADS B application such flight deck capability may become mandatory. It should be recalled that disabling the operation of the transponder will disable also the ACAS function.*

8.9.4.3 Means should be provided to the flight crew to disable the transmission of the barometric altitude.

## 9 COMPLIANCE WITH THIS AMC

### 9.1 Airworthiness

9.1.1 When showing compliance with this AMC, the following points should be noted:

- a) The applicant will need to submit, to the CAA, a certification plan and a compliance statement that shows how the criteria of this AMC have been satisfied, together with evidence resulting from the activities described in the following paragraphs.

- b) Compliance with the airworthiness requirements (e.g. EASA CS-25) for intended function and safety may be demonstrated by equipment qualification, safety analysis of the interface between the ADS-B equipment and data sources, structural analyses of new antenna installations, equipment cooling verification, evidence of a human to machine interface, suitable for ADS-B-NRA.
- c) The safety analysis of the interface between the ADS-B transmit system and its data sources should show no unwanted interaction under normal or fault conditions.
- d) The functionality for ADS-B-NRA application may be demonstrated by testing that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

9.1.2 The functionality for ADS-B-NRA application may be further demonstrated by ground testing, using ramp test equipment where appropriate, that verifies nominal system operation, the aircraft derived surveillance data contained in the ADS-B messages, and the functioning of system monitoring tools/fault detectors (if any).

*Note: this limited testing assumes that the air-ground surveillance systems have been shown to satisfactorily perform their intended functions in the flight environment in accordance with applicable requirements.*

To minimise the certification effort for follow-on installations, the applicant may claim credit, from the CAA, for applicable certification and test data obtained from equivalent aircraft installations.

## 9.2 Performance

Where compliance with a performance requirement cannot readily be demonstrated by a test, then the performance may be verified by an alternative method such as analysis, including statistical analysis of measurements under operational conditions.

## 9.3 Aircraft Flight Manual

9.3.1 The Aircraft Flight Manual (AFM) or the Pilot's Operating Handbook (POH), whichever is applicable, needs to provide at least a statement of compliance that the ADS-B System complies with this AMC 20-24 and if deviations are applicable. Deviations,<sup>1</sup> including those stated in this document, as appropriate may be included or referred to.

## 9.4 Existing installations

9.4.1 The applicant will need to submit, to the CAA, a compliance statement, which shows how the criteria of this AMC have been satisfied for existing installations.

---

<sup>1</sup> Refer to sections 8.3.3, 8.3.5 and 8.8.2.

Compliance may be supported by design review and inspection of the installed system to confirm the availability of required features, functionality and acceptable human-machine interface.

9.4.2 Where this design review finds items of non-compliance, the applicant may offer mitigation that demonstrates an equivalent level of safety and performance. Items presented by the applicant which impact safety, performance and interoperability requirements allocation will need to be coordinated in accordance with ED-78A.

## **10 OPERATIONAL CONSIDERATIONS**

### 10.1 General

10.1.1 The installation should be certified according to airworthiness considerations in section 8 prior to operational approval.

10.1.2 The assumptions in section 5, concerning Air Traffic and Communications Services Providers, and Aeronautical Information Services, should have been satisfied.

10.1.3 A unique ICAO 24 bit aircraft address should be assigned by the responsible authority to each airframe.

### 10.2 Operational Safety Aspects

10.2.1 In all cases, flight crews should comply with the surveillance provisions, schedules and relevant procedures contained in the Aeronautical Information Publications (AIP) published by the appropriate authorities.

10.2.2 Direct controller-pilot VHF voice communications should be available at all times.

10.2.3 If flight crew receive equipment indications showing that position being broadcast by the ADS-B system is in error (e.g. GPS anomaly), they should inform the ATSP, as appropriate, using any published contingency procedures.

10.2.4 When there is not an independent Flight Deck Control selection between the ADS-B function (ADS-B on/off) and the ATC transponder function, the crew must be fully aware that disabling the ADS B function will also lead to disable the ACAS function.

### 10.3 Operations Manual and Training

#### 10.3.1 Operations Manual

10.3.1.1 The Operations Manual should include a system description, operational and contingency procedures and training elements for use of the ADS-B-NRA application.

10.3.1.2 The Operations Manual, preferably section B, should contain the operational aspects described in this guidance material.



10.3.1.3 Operators operating under the provisions of ICAO Annex 6 Part II “International General Aviation – Aeroplanes” are not required to have an operations manual.

However, in order to use ADS-B applications, the operator should develop similar training and operational procedures to the ones described in this guidance material. This material may need to be approved by the State of Registry of the operator in accordance with national practice and sight of this approval may be required by the ADS-B navigation service provider.

#### 10.3.2 Flight Crew Training

10.3.2.1 Aircraft operators should ensure that flight crew are thoroughly familiar with all relevant aspects of ADS-B applications.

10.3.2.2 Flight crew training should address the:

- a) General understanding of ADS-B-NRA operating procedures;
- b) Specific ADS-B associated phraseology;
- c) General understanding of the ADS-B technique and technology;
- d) Characteristics and limitations of the flight deck human-machine interface, including an overview of ADS-B environment and system descriptions;
- e) Need to use the ICAO defined format for entry of the Aircraft Identification or Aircraft Registration marking as applicable to the flight;

*Note 1: ICAO Document 8168-OPS/611 Volume I (Procedures for Air Navigation Services) requires that flight crew of aircraft equipped with Mode “S” having an aircraft identification feature should set the aircraft identification into the transponder. This setting is required to correspond to the aircraft identification that has been specified at Item 7 of the ICAO flight plan and consists of no more than seven characters. If the aircraft identification consists of less than seven characters, no zeros, dashes or spaces should be added. If no flight plan has been filed, the setting needs to be the same as the aircraft’s registration, again, up to a maximum of seven characters.*

*Note 2: The shortened format commonly used by airlines (a format used by International Airlines Transport Association (IATA)) is not compatible with ICAO provisions for the flight planning and ATC services used by ATC ground systems.*

- f) Operational procedures regarding the transmission of solely the generic emergency flag in cases when the flight crew

actually selected a discrete emergency code (if implemented, refer to section 8.8) and SPI;

- g) Indication of ADS-B transmit capability within the ICAO flight plan but only when the aircraft is certified according to this AMC;
- h) Handling of data source errors (e.g. discrepancies between navigation data sources) (refer to 10.2.3);
- i) Incident reporting procedures;
- j) Crew Resources Management and associated human factors issues.

#### 10.4 Incident reporting

Significant incidents associated with ATC surveillance information transmitted by the ADS-B data link that affects or could affect the safe operation of the aircraft will need to be reported in accordance with EU-OPS 1.420 (or national regulations, as applicable).

#### 10.5 Minimum Equipment List

The MEL will need to be revised to indicate the possibility of despatch of aircraft with the ADS-B system unserviceable or partially unserviceable.

## 11 MAINTENANCE

11.1 Maintenance tests should include a periodic verification check of aircraft derived data including the ICAO 24 bit aircraft address using suitable ramp test equipment. The check of the 24 bit aircraft address should be made also in the event of a change of state of registration of the aircraft.

11.2 Maintenance tests should check the correct functioning of system fault detectors (if any).

11.3 Maintenance tests at ADS-B transmit system level for encoding altitude sensors with Gillham's code output should be based on the transition points defined in EUROCAE ED-26, Table 13.

11.4 Periodicity for the check of the ADS-B transmitter should be established.

## 12 AVAILABILITY OF DOCUMENTS

EASA documents are available from <http://www.easa.europa.eu>.

JAA documents are available from the JAA publisher Information Handling Services (IHS). Information on prices, where and how to order is available on both the JAA web site [www.jaa.nl](http://www.jaa.nl) and the IHS web site [www.avdataworks.com](http://www.avdataworks.com).

ICAO documents may be purchased from Document Sales Unit, International Civil Aviation Organisation, 999 University Street, Montreal, Quebec, Canada H3C 5H7, (Fax: 1 514 954 6769, e-mail: [sales\\_unit@icao.org](mailto:sales_unit@icao.org)) or through national agencies.

EUROCAE documents may be purchased from EUROCAE, 102 rue Etienne Dolet, 92240 MALAKOFF, France, (Fax: 33 1 46556265). Web site: [www.eurocae.org](http://www.eurocae.org).

RTCA documents may be purchased from RTCA, Incorporated, 1828 L Street, Northwest, Suite 820, Washington, D.C. 20036-4001 U.S.A. Web site: [www.rtca.org](http://www.rtca.org).

EUROCONTROL documents may be requested from EUROCONTROL, Documentation Centre, GS4, Rue de la Fusee, 96, B-1130 Brussels, Belgium; (Fax: 32 2 729 9109 or web site [www.eurocontrol.int](http://www.eurocontrol.int)).

FAA documents may be obtained from Department of Transportation, Subsequent Distribution Office SVC-121.23, Ardmore East Business Centre, 3341 Q 75<sup>th</sup> Avenue, Landover, MD 20785, USA.

Australia CASA documents are available from <http://www.casa.gov.au/>.

## Appendix 1 to AMC 20-24

### Appendix 1.1: Common Terms

Reference should be made to EUROCAE document ED-126 for the definitions of terms.

### Appendix 1.2: Abbreviations

ADS-B	Automatic Dependent Surveillance- Broadcast
ADS-B-NRA	Enhanced ATS in Non-Radar Areas using ADS-B Surveillance
AFM	Aircraft Flight Manual
ANC	Air Navigation Commission (ICAO)
ATSP	Air Traffic Service Provider
ATC	Air Traffic Control
ATS	Air Traffic Services
ATSU	Air Traffic Service Unit
ATM	Air Traffic Management
CASCADE	Co-operative ATS through Surveillance and Communication Applications Deployed in ECAC
EUROCONTROL	European Organisation for the Safety of Air Navigation
FAA	Federal Aviation Administration
GNSS	Global Navigation Satellite System
HPL	Horizontal Protection Limit
HIL	Horizontal Integrity Limit
ICAO	International Civil Aviation Organisation
INTEROP	Interoperability Requirements
MEL	Minimum Equipment List
NIC	Navigation Integrity Category
NACp	Navigation Accuracy Category
NUC	Navigation Uncertainty Category
POH	Pilots Operating Handbook
RFG	Requirement Focus Group
SIL	Surveillance Integrity Level
SPI	Special Position Identifier
SPR	Safety and Performance Requirements
SSR	Secondary Surveillance Radar
OSD	Operational Services and Environment Definition
Rc	Horizontal Position Integrity Containment Radius
TMA	Terminal Manoeuvring Area

## **Appendix 2 to AMC 20-24**

---

### **Appendix 2.1: Summary of core ADS-B-NRA Operational Assumptions**

- The ADS-B-NRA application assumes implementation of the procedures contained in the PANS-ATM ADS-B amendment. Fallback procedures from the radar environment apply to ADS-B-NRA when necessary. For example, ATC could apply alternate procedural separation (e.g., a vertical standard) during degraded modes.
- En route traffic density is assumed to be the same as in the current environment in which single radar coverage would enable the provision of a 5NM separation service for en route regions. This corresponds to low or medium density.
- Direct Controller-Pilot Communication (VHF) is assumed to be available at all times.
- It is assumed that the ADS-B coverage is known to the Controller in the controlled airspace.

### **Appendix 2.2: Summary of core ADS-B-NRA Ground Domain Assumptions**

- Controller operating procedures are assumed to be unaffected by the selection of an ADS-B data link, i.e., the ADS-B data link is assumed to be transparent to the controller.
- Air Traffic Controllers are assumed to follow existing procedures for coordination and transfer of aircraft. This applies to coordinating appropriate information with downstream units and complying with local agreements established between ATC units regarding separation standards to be established prior to entry into a bordering ATC unit.
- Appropriate ATS authorities are assumed to provide controllers with adequate contingency procedures in the event of ADS-B failures or degradation.
- It is assumed that there is a monitoring capability in the ADS-B Receive Subsystem that monitors the health and operation of the equipment and sends alerts and status messages to the Air Traffic Processing Subsystem.

## Appendix 3 to AMC 20-24

### Summary of ADS-B-NRA Airborne Safety and Performance Requirements

Parameter	Requirement
Horizontal Position and Horizontal Position Quality Indicator(s)	$10^{-5}/fh$
ADS-B System Continuity	$2 \cdot 10^{-4}/fh$
Horizontal Position Latency <sup>1</sup>	1.5 sec/95%

Table 1: Overall Minimum Airborne ADS-B System<sup>2</sup> Requirements

Parameter	Requirement
Horizontal Position Source	
— Accuracy (95%)	— 5 NM Sep: 926 m
— Integrity	
— Containment Radius (Rc)	— 5 NM Sep: Rc=2 NM
— Source Failure Probability	$10^{-4}/h^3$
— Alert Failure Probability	$10^{-3}$ (per position source failure event)
— Time to Alert	— 5 NM Sep: 10 sec

Table 2: Minimum Horizontal Position Source Requirements

*Note: for DO-260 based ADS-B transmit systems, the related encoding of the horizontal position quality indicator through the Navigation Uncertainty Category (NUC) effectively leads to a containment radius requirement of 1NM for a 5 NM separation service.*

*Note: accuracy and integrity containment radius requirements are expressed here as guidance to related horizontal position source regulation (refer to section 8.4).*

*Note: the containment bound requirements reflect the outcomes of both the collision risk assessment (CAP) and time-to-alert assessment.*

*Note: the accuracy and integrity containment radius requirements have to be met by the horizontal position source, taking into account the effects of on-board latency (if not compensated for).*

*An uncompensated latency of 1.5 seconds translates into a dilution in the order of 450 metres (assuming an aircraft speed of 600 knots in en-route airspace). This value of 450 metres has to be added to the actual performance of the horizontal position source(s), the sum of which has to be within the required bounds.*

<sup>1</sup> Uncompensated delay measured from to the time of validity of position measurement until ADS-B transmission (i.e. at RF level).

<sup>2</sup> As defined in section 6.

<sup>3</sup> For GNSS based functions, expressed as an assumption of GNSS performance.

The GNSS equipment specified in 8.4.6 meets the overall accuracy and integrity requirements, including the effects of an uncompensated latency of maximum 1.5 second accumulated up to the time of transmission.

Parameter	Requirement
Barometric Altitude	<ul style="list-style-type: none"> <li>– Accuracy: as per the installed sensors (refer to section 8.5.2)</li> <li>– Maximum Latency: 1 sec (as for SSR)</li> </ul>
Aircraft Identification, SPI, Emergency Status	As for SSR [AMC20-13].

Table 3: Other Minimum ADS-B Surveillance Data Requirements

Parameter	Loss	Corruption	Note
Barometric Altitude	Minor	Minor	As for SSR.
Aircraft Identification	Minor	Minor	As for SSR.

Table 4: Failure Condition Categories

## Appendix 4 to AMC 20-24

### Appendix 4.1: Summary of ADS-B-NRA Air-to-ground Interoperability Requirements

The minimum set of parameters that should be provided to support the ADS-B-NRA application are summarised in the following table extracted from ED-126:<sup>1</sup>

Parameter	BDS register	Version 0		Version 1
		ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED102	DO-260A
Aircraft identification	0.8	§2.3.4	§2.2.3.2.5	§2.2.3.2.5
SPI <sup>2</sup>	0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2
Emergency indicator	0.5	§2.3.2.6	§2.2.3.2.3.2	§2.2.3.2.3.2
Barometric altitude	0.5	§2.3.2.4	§2.2.3.2.3.4	§2.2.3.2.3.4
Quality indicator (NUC/NIC)	0.5	§2.3.1	§2.2.3.2.3.1	§2.2.3.2.3.1
Airborne Position	Latitude	0.5	§2.3.2.3	§2.2.3.2.3.7
	Longitude	0.5	§2.3.2.3	§2.2.3.2.3.8
Emergency status <sup>3 4</sup>	6.1	Table 2-97	§2.2.3.2.7.9	§2.2.3.2.7.8

<sup>1</sup> The notion of version “0” and “1” differentiates between DO-260/ED-102 and DO-260A transponders.

<sup>2</sup> If provided by flight deck controls.

<sup>3</sup> If provided by flight deck controls.

<sup>4</sup> For special conditions under which the non-transmission of selected discrete emergency codes is allowed, refer to Section 8.8.2.

Parameter	BDS register	Version 0		Version 1
		ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED102	DO-260A
Quality indicator (NACp)	6.5	No definition	No definition	§2.2.3.2.7.2.7
Quality indicator (SIL)	6.5	No definition	No definition	§2.2.3.2.3.1.1
Version Indicator <sup>1</sup>	6.5	No definition	No definition	§A.1.4.10.5

Table 5: Mandatory ADS-B-NRA Parameters

The minimum set of parameters that should be provided to support the ADS-B-NRA application are summarised in the following table extracted from ED-126:

Parameter	BDS register	Version 0		Version 1
		ICAO Annex 10 Amendment 79, VOL III, App to chap 5	DO-260/ED102	DO-260A
Airborne Ground Velocity	0.9	§2.3.5	§2.2.3.2.6	§2.2.3.2.6

Table 6: Optional ADS-B-NRA Parameters

## Appendix 4.2: Guidance on Encoding of Positional Quality Indicators

In order to be able to check the compliance of the actually transmitted ADS-B data with the required quality on the recipient side, ADS-B message transmissions contain “Quality Indicators”. These are expressed for ED-102/DO-260 and DO-260A compliant ADS-B transmit systems as follows:

- ED-102/DO-260: Navigation Uncertainty Category (NUC), a combined expression of (accuracy and) integrity requirements through a single parameter;
- DO-260A: Navigation Accuracy Category (NACp) to express the position accuracy (as a 95 percentile), Navigation Integrity Category (NIC) to express the integrity containment radius and Surveillance Integrity Level (SIL) to specify the probability of the true position lying outside that containment radius without alerting.

Minimum acceptable NUC and NIC/NACp values in support of 5 NM ADS-B-NRA separation services, based on the requirements summarised in Table 2 of Appendix 4, are as follows in line with the “NIC/NACp to NUC” conversion table below.

NUC values (encoding based on HPL, with the accuracy requirements met by GNSS systems by design and in line with the related NACp values in below conversion table):

- 5 NM separation: NUC = 4;

The corresponding NIC/NACp values are as follows.

<sup>1</sup> Only for DO-260A based ADS-B transmit systems.



– 5 NM separation: NIC = 4, NACp = 5,

The SIL value is established to  $SIL \geq 2$  in line with the combination of the position source failure and position integrity alert failure requirements, as summarised in Table 2 of Appendix 4.

*Note 1: In case the SIL value is not output by the position data sources, it is recommended that the ADS-B transmit system provides for the static setting of SIL as part of the installation procedure and as demonstrated for the applicable position data source configuration.*

*Note 2: ED-126 provides, based on its reference collision risk analysis only, arguments for an equally appropriate encoding of a  $SIL=2$  as a matter of expressing the system integrity as well. As for the presentation of the values presented in this document, it is at the discretion of the ATSP to decide upon the appropriate threshold values required in support of the separation services in its airspace.*

NUC (max Rc NM)		NIC (max Rc NM)		NACp (95% bound)	
<b>9</b>	(0.003)	<b>11</b>	(0.004)	<b>11</b>	(3 m)
<b>8</b>	(0.01)	<b>10</b>	(0.013)	<b>10</b>	(10 m)
-		<b>9</b>	(0.04)	<b>9</b>	(30 m)
<b>7</b>	(0.1)	<b>8</b>	(0.1)	<b>8</b>	(0.05 NM)
<b>6</b>	(0.2)	<b>7</b>	(0.2)	<b>7</b>	(0.1 NM)
<b>5</b>	(0.5)	<b>6</b>	(0.6)	<b>6</b>	(0.3 NM)
<b>4</b>	(1.0)	<b>5</b>	(1.0)	<b>5</b>	(0.5 NM)
<b>3</b>	(2.0)	<b>4</b>	(2.0)	<b>4</b>	(1 NM)
-		<b>3</b>	(4.0)	<b>3</b>	(2 NM)
-		<b>2</b>	(8.0)	<b>2</b>	(4 NM)
<b>2</b>	(10)	<b>1</b>	(20)	<b>1</b>	(10 NM)
<b>1</b>	(20)	<b>1</b>	(20)	<b>1</b>	(10 NM)
<b>0</b>	(no integrity)	<b>0</b>	(> 20)	<b>0</b>	(unknown)

Table 7: NUC conversion to NIC and NACp

## AMC 20-25A

### AMC 20-25A Airworthiness considerations for Electronic Flight Bags (EFBs)

---

#### 1 PURPOSE AND SCOPE

This Acceptable Means of Compliance (AMC) is one, but not the only, means to obtain an airworthiness approval for installed electronic flight bags (EFBs) and for EFB installed resources. Additional guidance material can be found in ICAO Doc 10020 'Manual of Electronic Flight Bags'.

Operational considerations for the evaluation and approval of the use of EFB applications can be found in MCAR-Air Operations.

#### 2 REFERENCE DOCUMENTS

##### 2.1 Related Certification Specifications

EASA CS 25.561, 25.777, 25.789, 25.1301, 25.1302, 25.1309, 25.1316, 25.1321, 25.1322, 25.1357, 25.1431, 25.1529, 25.1581

EASA CS 23.2270, 23.2500, 23.2505, 23.2510, 23.2600, 23.2605, 23.2620

EASA CS 29.1301, 29.1309, 29.1321, 29.1322, 29.1431, 29.1581

EASA CS 27.1301, 27.1309, 27.1321, 27.1322, 27.1581

Appendix G to CS-23, Appendix H to CS-25, and Appendices A to CS-27 and CS-29: Instructions for Continued Airworthiness

EASA Special Condition: Information Security Protection of Aircraft Systems and Networks

##### 2.2 Related Guidance Material

EASA AMC 25.1581 Appendix 1 – Computerised Aeroplane Flight Manual

EASA AMC 25.1309 System Design and Analysis

EASA AMC 25-11 Electronic Flight Deck Displays

EUROCAE ED-130() Guidance for the Use of Portable Electronic Devices (PEDs) on Board Aircraft

EUROCAE ED-12() Software Considerations in Airborne Systems and Equipment Certification

EUROCAE ED-14D/DO-160D (or later revisions) Environmental Conditions and Test Procedures for Airborne Equipment

EUROCAE ED-76/RTCA DO-200A (or later revisions) Standards for Processing Aeronautical Data

EUROCAE ED-80() Design Assurance Guidance for Airborne Electronic hardware

FAA AC 120-76() Guidelines for the Certification, Airworthiness, and Operational Approval of Electronic Flight Bag Computing Devices

FAA AC 20-173 Installation of Electronic Flight Bag Components

EASA ETSO-C165A/FAA TSO-C165A Electronic Map Systems for Graphical Depiction of Aircraft Position / Electronic Map Display Equipment for Graphical Depiction of Aircraft Position (Own-ship)

RTCA DO-178() Software Considerations in Airborne Systems and Equipment Certification

RTCA DO-254() Design Assurance Guidance for Airborne Electronic Hardware

RTCA DO-257() Minimum Operation Performance Standards for the Depiction of Navigational Information on Electronic Maps

RTCA DO-311() Minimum Operational Performance Standards for Rechargeable Lithium Battery Systems

TGM/21/07 Electrical Wiring Policy for certification of large Aeroplanes, Engines and Propeller

### **3 GLOSSARY OF TERMS IN THE CONTEXT OF THIS AMC**

#### **3.1 Consumer device**

Electronic equipment primarily intended for non-aeronautical use.

#### **3.2 Data connectivity for EFB systems**

Data connectivity for EFB system supports either uni- or bi-directional data communication between the EFB and other aircraft systems (e.g. avionics).

Direct interconnectivity between EFBs or direct connectivity between EFBs and ground systems as with a T-PED (e.g. GSM, Bluetooth) are not covered by this definition.

#### **3.3 Electronic Flight Bag (EFB)**

An electronic information system, comprised of equipment and applications for flight crew, which allows for the storing, updating, displaying, and processing of EFB functions to support flight operations or duties.

#### **3.4 EFB host platform**

When considering an EFB system, the EFB host platform is the equipment (i.e. hardware) in which the computing capabilities and basic software (e.g. operating system, input/output software) reside.

#### **3.5 EFB software application**

Software installed on an EFB system that provides specific operational functionality.

#### **3.6 EFB system**

An EFB system comprises the hardware (including any battery, connectivity provision, I/O devices) and software (including databases and operating system) that is needed to support the intended EFB application(s).

#### **3.7 EFB system supplier**

The company that is responsible for developing, or for having developed the EFB system or part of it. The EFB system supplier is not necessarily a host platform or aircraft manufacturer.

### **3.8 Mounting device**

A mounting device is an aircraft certified part that secures portable or installed EFB, or EFB system components.

### **3.9 Portable Electronic Device (PED)**

PEDs are any kind of electronic device, typically, but not limited to, consumer electronics that is brought on board the aircraft by crew members, passengers, or as part of the cargo, and that is not included in the configuration of the certified aircraft. It includes all equipment that is able to consume electrical energy. The electrical energy can be provided from internal sources such as batteries (chargeable or non-rechargeable), or the devices may also be connected to specific aircraft power sources.

### **3.10 Software application developer**

The company responsible for developing, or for having developed a particular software application.

### **3.11 Transmitting PED (T-PED)**

PEDs that have intended radio frequency (RF) transmission capabilities.

## **4 SYSTEM DESCRIPTION AND CLASSIFICATION OF EFB SYSTEMS**

EFB hardware are classified in two categories: portable and installed.

### **4.1 Portable EFB**

A portable EFB is a portable EFB host platform, that is used on the flight deck, and that is not part of the certified aircraft configuration.

Except for installed components, portable EFBs are outside the scope of this document.

Any EFB component that is either not accessible in the flight crew compartment by the flight crew members or not removable by the flight crew, should be installed as 'certified equipment' covered by a type certificate (TC), changed TC or supplemental (S)TC.

### **4.2 Installed EFB**

#### **Definition**

Installed EFB, means an EFB host platform that is installed in the aircraft and is considered as an aircraft part, covered, thus, by the aircraft airworthiness approval.

#### **Complementary characteristics**

An installed EFB is managed under the aircraft type design configuration.

In addition to hosting EFB applications (refer to point CAT.GEN.MPA.141 for the definitions and characteristics of EFB applications), an installed EFB may host certified applications, provided that the EFB meets the applicable certification specifications for hosting such applications, including assurance that the non-certified software applications do not adversely affect the certified application(s). For example, a robust partitioning mechanism is one possible means to ensure the independence between certified applications and the other types of applications.

## **5 AIRWORTHINESS CONSIDERATIONS**

Airworthiness approval is necessary for installed EFB systems, as well as for EFB installed resources.

### **5.1 Hardware airworthiness approval**

#### **5.1.1 Installed resources**

Installed resources are the input/output components external to the EFB host platform itself, such as an installed remote display, a control device (e.g. a keyboard, pointing device, switches, etc.), or a docking station.

The installed resources should be dedicated to EFB functions only, or in the case of use of resources shared with avionics, this possibility shall be part of the approved type design. It should be demonstrated, using the appropriate level of assessment, that the integration in the aircraft of the EFB and the EFB software applications does not jeopardise the compliance of the aircraft installed systems and equipment (including the shared resources) with the applicable certification specifications such as CS 25.1302 or 25.1309.

Installed resources require an airworthiness approval.

##### **5.1.1.1 Mounting device**

The mounting device (or other securing mechanism) attaches or allows the mounting of the EFB system. The EFB system may include more than one mounting device if it consists of separate items (e.g. one docking station for the EFB host platform and one cradle for the remote display).

The mounting device should not be positioned in such a way that it creates a significant obstruction to the flight crew's view or hinders physical access to aircraft controls and/or displays, flight crew ingress or egress, or external vision. The design of the mounting device should allow the user easy access to any item of the EFB system, even if stowed, and notably to the EFB controls and a clear view of the EFB display while in use. The following design practices should be considered:

- (a) The mounting device and associated mechanisms should not impede the flight crew in the performance of any task (whether normal, abnormal, or emergency) that are associated with operating any aircraft system.
- (b) When the mounting device is used to secure an EFB display (e.g. portable EFB, installed EFB side display), the mount should be able to be locked in position easily. If necessary, the selection of positions should be adjustable enough to accommodate a range of flight crew member preferences. In addition, the range of available movement should accommodate the expected range of users' physical abilities (i.e. anthropometrics constraints). Locking mechanisms should be of a low-wear type that will minimise slippage after extended periods of normal use.
- (c) Crashworthiness considerations should be taken into account in the design of this device. This includes the appropriate restraint of any device when in use.
- (d) When the mounting device is used to secure an EFB display (e.g. a portable EFB, an installed EFB side display), provision should be made to secure or lock the mounting device in a position out of the way of flight crew operations when it is not in use. When stowed, the device and its securing mechanism should not intrude into the flight crew compartment space to the extent that they cause either visual or physical obstruction of flight controls/displays and/or egress routes.
- (e) Mechanical interference issues of the mounting device, either on the side panel (side stick controller) or on the control yoke, in terms of full and free movement under all operating conditions and non-interference with buckles, etc. For yoke mounted devices, (supplemental)-type-certificate-holder data should be obtained to show that the mass inertia effect on column force has no adverse effect on the aircraft handling qualities.
- (f) Adequate means should be provided (e.g. hardware or software) to shut down the portable EFB when its controls are not accessible by the flight crew when strapped in the normal seated position. This objective can be achieved through a dedicated installed resource certified according to 5.1.1 (e.g. a button accessible from the flight crew seated position).

#### **5.1.1.2 Characteristics and placement of the EFB display**

##### **(a) Placement of the display**

The EFB display and any other element of the EFB system should be placed in such a way that they do not unduly impair

the flight crew's external view during any phase of the flight. Equally, they should not impair the view of or access to any flight-crew-compartment control or instrument.

The location of the display unit and the other EFB system elements should be assessed for their impact on egress requirements.

When the EFB is in use (intended to be viewed or controlled), its display should be within 90 degrees on either side of each flight crew member's line of sight.

Glare and reflection on the EFB display should not interfere with the normal duties of the flight crew or unduly impair the legibility of the EFB data.

The EFB data should be legible under the full range of lighting conditions expected in a flight crew compartment, including direct sunlight.

In addition, consideration should be given to the potential for confusion that could result from the presentation of relative directions when the EFB is positioned in an orientation that is inconsistent with that information. For example, it may be misleading if the aircraft heading indicator points to the top of the display and the display is not aligned with the aircraft longitudinal axis. This does not apply to charts that are presented in a static way (e.g. with no HMI mechanisation such as automatic repositioning), and that can be considered to be similar to paper charts.

**(b) Display characteristics**

Consideration should be given to the long-term degradation of a display as a result of abrasion and ageing.

Users should be able to adjust the screen brightness of an EFB independently of the brightness of other displays in the flight crew compartment. In addition, when incorporating an automatic brightness adjustment, it should operate independently for each EFB in the flight crew compartment. Brightness adjustment using software means may be acceptable providing that this operation does not affect adversely the crew workload.

Buttons and labels should have adequate illumination for night use. 'Buttons and labels' refers to hardware controls located on the display itself.

The 90-degree viewing angle on either side of each flight crew member's line of sight may be unacceptable for certain EFB applications if aspects of the display quality are degraded at

large viewing angles (e.g. the display colours wash out or the displayed colour contrast is not discernible at the installation viewing angle).

**(c) Applicable specifications**

In addition to the specifications of this section, each EFB system should be evaluated against CS 23.1321, CS 25.1321, CS 27.1321, or CS 29.1321, as applicable.

If the display is an installed resource, it should be assessed against CS 25.1302 or in accordance with the applicable certification basis.

**5.1.1.3 EFB data connectivity**

Portable EFBs that have data connectivity to aircraft systems, either wired or wireless, may receive or transmit data to and from aircraft systems, provided the connection (hardware and software for data connection provisions) and adequate interface protection devices are incorporated into the aircraft type design.

Connectivity provisions for a portable EFB may allow the EFB to receive any data from aircraft systems, but data transmission from EFBs to aircraft systems is limited to:

- (a) systems whose failures have no safety effect or a minor safety effect at the aircraft level (e.g. printers);
- (b) aircraft systems that have been certified with the purpose of providing connectivity to non-certified devices such as PEDs or EFBs in accordance with the limitations established in the AFM; and
- (c) EFB system installed resources according to Section 5.1.1.

EFB data connectivity should be validated and verified to ensure non-interference with and isolation from certified aircraft systems during data transmission and reception.

The safety assessment of the EFB data connectivity installation should include an analysis of vulnerabilities to new threats that may be introduced by the connection of the EFB to the aircraft systems (malware and unauthorised access) and their effect on safety. This assessment should be independent and should not take any credit from the operational assessment of EFB system security, which is intended to protect EFB systems themselves.

For aircraft systems certified for the purpose of receiving data from PEDs or EFBs (case (b) above), their connectivity with PEDs/EFBs should be taken into account in their demonstration of compliance with requirements such as CS



25.1302 and 25.1309. The applicant should in particular, conduct a safety assessment demonstrating that the failure conditions associated with the reception of erroneous PED/EFB data have criticalities that are not higher than minor. Adequate design measures such as preliminary flight crew review and acceptance of the imported parameters that mitigate the risk for using erroneous data should be implemented if needed.

Any consequent airworthiness limitations should be included in the AFM (please refer to 5.2.1).

#### **5.1.1.4 Connecting cables**

When cabling is installed to mate aircraft systems with an EFB,

- (a) if the cable is not run inside the mount, the cable should not hang loosely in such a way that compromises task performance and safety. Flight crew should be able to easily secure the cables out of the way during operations (e.g., by using cable tether straps);
- (b) cables that are external to the mounting device should be of sufficient length so that they do not obstruct the use of any movable device on the flight crew compartment; and
- (c) installed cables are considered electrical wiring interconnection systems and, therefore, need to comply with CS-25 Subpart H (FAA Part-25, Transport Category Airplanes) or TGM/21/07 (FAA Part-29, Transport Category Rotorcraft).

#### **5.1.2 Installed EFB**

An installed EFB is considered to be a part of the aircraft, and, therefore, requires a full airworthiness approval. This host platform includes the operating system (OS).

The assessment of compliance with the airworthiness requirements would typically include two specific areas:

- (a) the safety assessment addressing failure conditions of the EFB system hardware of any certified application installed on the EFB, and the partition provided for uncertified applications and miscellaneous software applications; and
- (b) hardware and operating system software qualification conducted in accordance with the necessary development assurance level (DAL) for the system and its interfaces.

### **5.2 Certification documentation**

#### **5.2.1 Aircraft flight manual**

For installed EFBs and certified installed resources, the AFM section or an aircraft flight manual supplement (AFMS) should contain:

- (a) a statement of the limited scope of the airworthiness approval of EFB provisions (e.g. these EFB provisions are only intended for EFB applications. The airworthiness approval does not replace the operational assessment for the use of the EFB system).
- (b) the identification of the installed equipment, which may include a very brief description of the installed system or resources; and
- (c) appropriate amendments or supplements to cover any limitations concerning:
  - (1) the use of the EFB host platform for the installed EFB system; and
  - (2) the use of the installed EFB provisions/resources for the portable EFB system.

For this purpose, the AFM(S) should refer to any guidelines (relevant to the airworthiness approval), intended primarily for EFB software application developers or EFB system suppliers.

#### **5.2.2 Guidelines for EFB software application developers (installed EFB and certified installed resources)**

TC/STC holders for EFB installed resources or installed EFBs should compile and maintain guidelines to provide a set of limitations, considerations, and guidance to design, develop, and integrate software applications into the installed EFB or with certified resources for portable EFB. The guidelines should address, at least, the following:

- (a) a description of the architecture of the EFB installed components;
- (b) the development assurance level (DAL) of the EFB component and any assumptions, limitations, or risk mitigation means that are necessary to support this;
- (c) information necessary to ensure the development of a software application that is consistent with the avionics interface and the human machine interface that is also accurate, reliable, secure, testable, and maintainable;
- (d) integration procedures between any new software application and those already approved; and
- (e) guidelines on how to integrate any new software application into the installed platform or installed resources.

The guideline document should be available at least to the aircraft operator and the CAA.

### **5.2.3 Guidelines for EFB system suppliers (installed resources for portable EFBs)**

TC/STC holders for installed resources of portable EFBs should provide a set of requirements and guidelines to integrate the portable EFB into the installed resources, and to design and develop EFB software applications.

Guidelines that are intended primarily for use by the EFB system supplier should address, at least, the following:

- (a) A description of the EFB installed resources and associated limitations, if any. For example, the:
  - (1) intended function, limitations of use, etc.;
  - (2) characteristics of the mounting devices, display units, control and pointing devices, printer, etc.;
  - (3) maximum authorised characteristics (dimensions, weight, etc.) of the portable parts of the EFB system that is supported by the mounting devices;
  - (4) architectural description of the EFB provisions, including normal/abnormal/manual/automatic reconfigurations; and
  - (5) normal/abnormal/emergency/maintenance procedures including the allowed phases of the flight.
- (b) Characteristics and limitations, including safety and security considerations concerning:
  - (1) the power supply;
  - (2) the laptop battery; and
  - (3) data connectivity.

The guidelines should be available at least to the operator and the CAA.

## SUBPART B — LIST OF AMC-20 ITEMS

AMC-20 reference	Title	Last amended by
<a href="#">AMC 20-6B</a>	Extended Range Operation with Two-Engine Aeroplanes ETOPS Certification and Operation	AMC-20 Issue 1.00
<a href="#">AMC 20-20B</a>	Continuing Structural Integrity Programme	AMC-20 Issue 1.00
<a href="#">AMC 20-21</a>	Programme to enhance aeroplane Electrical Wiring Interconnection System maintenance	AMC-20 Issue 1.00
<a href="#">AMC 20-22</a>	Aeroplane Electrical Wiring Interconnection System Training Programme	AMC-20 Issue 1.00
<a href="#">AMC 20-24</a>	Certification Considerations for the Enhanced ATS in Non-Radar Areas using ADS-B Surveillance (ADS-B-NRA) Application via 1090 MHZ Extended Squitter	AMC-20 Issue 1.00
<a href="#">AMC 20-25A</a>	Airworthiness consideration for Electronic Flight Bags (EFBs)	AMC-20 Issue 1.00