AMC-20 AMENDMENT 21 — CHANGE INFORMATION

EASA publishes amendments to the General Acceptable Means of Compliance for Airworthiness of Products, Parts and Appliances (AMC-20) as consolidated documents. These documents are used for establishing the certification basis for applications made after the date of entry into force of the applicable amendment.

Consequently, except for a note '[Amdt 20/21]' under the amended paragraph, the consolidated text of the AMC does not allow readers to see the detailed changes compared to the previous amendment. To allow readers to see these detailed changes, this document has been created. The same format as for the publication of notices of proposed amendments (NPAs) is used to show the changes:

— deleted text is ~~struck through~~;

— new or amended text is highlighted in blue;

— an ellipsis '[…]' indicates that the rest of the text is unchanged.

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.

An applicant may elect to use another means of compliance which should be acceptable to ~~the Agency~~ EASA or the competent authority. Compliance with this AMC is not mandatory. 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 to (S)TC holders that seek~~ing~~ ETOPS type design approval of an engine or a particular ~~airplane~~aeroplane-engine combination. These aeroplanes~~airplanes~~ may be used in extended-range operations.
- Chapter III of this AMC provides guidance to operators that seek~~ing~~ ETOPS operational approval to conduct extended-range operations under the requirements of the applicable operational regulations~~[1]~~.

The purpose of this revision No. 3 of AMC20-6 is to remove:

(a) the airworthiness criteria applicable to non-ETOPS operations between 120 minutes and 180 minutes; and

(b) the weight discriminant for the non-ETOPS operations.

~~The purpose of this revision No. 2 of AMC20-6 is to develop guidance for obtaining approval for diversion times exceeding 180 minutes.~~

ETOPS type design approvals and operational approvals obtained before the issue of this revision remain valid. Extension of existing ETOPS type design approvals or operational approvals beyond 180 minutes should be issued in accordance with this revision.

New ETOPS type design approvals and operational approvals should be issued in accordance with this revision.

~~[1] EU-OPS until operational requirements Part-SPA Subpart-ETOPS are in force.~~

SECTION 2: RELATED REFERENCES

CS-Definitions: ED Decision No. 2003/011/RM as last amended.

CS-E: ED Decision No. 2003/9/RM, as last amended (CS-E 1040).

CS-25: ED Decision No. 2003/2/RM, as last amended, (CS 25.901, 25.903, 25.1309, 25.1351(d), 25.1419, 25.1535, CS-25 Subpart J).

~~EU-OPS: Council Regulation (EEC) No 3922/91, as last amended.~~

Part-21: Annex I to Commission Regulation (~~EC~~EU) No ~~1702/2003~~748/2012, as last amended.

Part-M: Annex I to Commission Regulation (~~EC~~EU) No ~~2042/2003~~1321/2014, as last amended.

Part-145: Annex II to Commission Regulation (~~EC~~EU) No ~~2042/2003~~ 1321/2014, as last amended.

SECTION 3: ABBREVIATIONS

AFM: ~~Airplane~~ aeroplane flight manual

ATS: air traffic services

CAME: continuing airworthiness management exposition

CAMO: continuing airworthiness management organisation approved pursuant to Part-M Subpart-G

CG: centre of gravity

IFSD: in-flight shut-down

MCT: maximum continuous thrust

MMEL: master minimum equipment list

MEL: minimum equipment list

RFFS rescue and firefighting 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 certifi~~cat~~ed limits of the aeroplane, selected by the operator and approved by the competent authority.

(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 ~~s~~Section 4 to ~~of~~ 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 ~~of~~ 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~~ 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 Agency~~ EASA 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~~s~~ 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~~' capability~~ 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, ~~or with a maximum take-off mass of 45360 kg 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 ~~and a maximum take-off mass of less than 45360 kg~~, 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 ~~means~~ when an engine ceases to function and is shut down ~~shutdown~~, 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.

~~the Agency~~ EASA 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 ~~shutdown~~. These events as well as engine failures occurring before take-off decision speed or after touchdown ~~touch-down~~, although not counted as IFSDs, shall be reported to the competent authority 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 criteria in this AMC and Appendices 1 and 2 to ~~of~~ this AMC. 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.

Any proposed increase in the maximum approved diversion time(s), or changes to the aircraft or engine, should be re-assessed by the (S)TC holder in accordance with Part 21A.101 to establish if any of the type design criteria in this AMC should be applied.

h. Operator's approved diversion time

Operator's approved diversion time is the maximum time authorised by the competent authority ~~Competent Authority~~ 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 ~~are~~ 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 (see Appendix 1).

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

SECTION 1: APPLICABILITY

This chapter is applicable to (S)TC applicants or holders that seek~~ing~~ ETOPS type design approval for an engine or a particular ~~airplane~~aeroplane-engine combination.

SECTION 2: COMPETENT AUTHORITY

The competent authority ~~Competent Authority~~ for the issue of an ETOPS type design approval is ~~the Agency~~ EASA.

SECTION 3: GENERAL

When a two-engine aeroplane is intended to be used in extended-range operations, a determination should be made that the design features are suitable for the intended operation. The ETOPS significant system for the particular airframe/engine combination should be shown to be designed to fail-safe criteria and it should be determined that it can achieve a level of reliability suitable for the intended operation. In some cases, modifications to systems may be necessary to achieve the desired reliability.

SECTION 4: ELEGIBILITY

To be eligible for extended-range operations ~~(ETOPS)~~, the specified airframe/engine combination, should have been certifi~~cat~~ed according to the airworthiness standards of large aeroplanes and engines.

The process to obtain a type design ETOPS approval requires the applicant to show that in accordance with the criteria established in this ~~c~~Chapter II and Appendices 1 and 2:

- the design features of the particular airframe/engine combination are suitable for the intended operations; and,
- the particular airframe/engine combination, having been recognised eligible for ETOPS, can achieve a sufficiently high level of reliability.

The required level of reliability of the airframe/engine combination can be validated by the following methods:

(1) METHOD 1: in-service experience for ETOPS type design approval defined in ~~s~~Section 6.1 of and Appendices 1 and 2 ~~of~~ to this AMC, or

(2) METHOD 2: a programme of design, test and analysis agreed between the applicant and ~~the Agency~~ EASA, (i.e. ~~A~~approval ~~P~~plan) for Early ETOPS type design approval defined in Appendices 1 and 2 ~~of~~ to this AMC.

SECTION 5: REQUEST FOR APPROVAL

An applicant for, and holders of a (S)TC requesting a determination that a particular airframe/engine combination is a suitable type design for extended-range operation, should apply to ~~the Agency~~ EASA. ~~the Agency~~ EASA will then initiate an assessment of the engine and airframe/engine combination in accordance with the criteria laid down in this ~~c~~Chapter II and ~~Appendix 1 & 2 of~~ in Appendices 1 and 2 to this AMC.

SECTION 6: VALIDATION METHODS OF THE LEVEL OF RELIABLITY

This chapter together with ~~Appendix~~ Appendices 1 and 2 to this AMC should be followed to assess the reliability level of the propulsion system and airframe systems for which ETOPS type design approval is sought. ~~Appendix~~ Appendices 1 and 2 describe both the in-service experience method and the early ETOPS method.

6.1 METHOD 1: IN-SERVICE EXPERIENCE FOR ETOPS TYPE DESIGN APPROVAL

Prior to the ETOPS type design approval, it should be shown that the world fleet of the particular airframe/engine combination for which approval is sought can achieve or has achieved, as determined by ~~the Agency~~ EASA (see Appendices ~~Appendix~~ 1 and 2), an acceptable and reasonably stable level of propulsion system in-flight shutdown (IFSD) rate and airframe system reliability.

Engineering and operational judgement applied in accordance with the guidance provided ~~outlined~~ in Appendix 1 will then be used to determine that the *IFSD rate objective* for all independent causes can be or has been achieved. This assessment is an integral part of the determination in ~~s~~Section 7 paragraph (2) for type design approval. This determination of propulsion system reliability is derived from a world fleet database ~~data base~~ containing, in accordance with requirements of Appendix 1, all in-flight shutdown events, all significant engine reliability problems, design and test data and available data on cases of significant loss of thrust, including those where the propulsion system failed or the engine was throttled back or shut down by the pilot. This determination will take due account of the approved maximum diversion time, proposed rectification of all identified propulsion and ETOPS significant systems problems, as well as events where in-flight starting capability may be degraded.

6.2 METHOD 2: EARLY ETOPS

ETOPS approval is considered feasible at the introduction to service of an airframe/engine combination as long as ~~the Agency~~ EASA is totally satisfied that all aspects of the approval plan have been completed. ~~the Agency~~ EASA must be satisfied that the approval plan achieves the level of safety intended in this AMC and in the aeroplane and engine certification bases. Any non-compliance with the approval plan can result in a lesser approval than sought for.

(S)TC holders will be required to respond to any incident or occurrence in the most expeditious manner. A serious single event or series of related events could result in immediate revocation of ETOPS type design approval. Any isolated problem not justifying immediate withdrawal of approval, should be addressed within 30 days in a resolution plan approved by ~~the Agency~~ EASA. (S)TC holders will be reliant on operators to supply incident and occurrence data.

SECTION 7: EVALUATION CRITERIA OF THE ETOPS TYPE DESIGN

The applicant should conduct an evaluation of failures and failure combinations based on engineering and operational consideration as well as acceptable fail-safe methodology. The evaluation should consider effects of operations with a single engine, including allowance for additional stress that could result from failure of the first propulsion system. Unless it can be shown that equivalent safety levels are provided or the effects of failure are minor, failure and reliability analysis should be used as guidance in verifying that the proper level of fail-safe design has been provided. Excluding failures of the engine, any system or equipment failure condition, or combination of failures that affects the aeroplane or engine and that would result in a need for a diversion, should be considered a Major event (CS 25.1309) and therefore the probability of such should be compatible with that safety objective. The following criteria are applicable to the extended-range operation of aeroplanes with two engines:

(1) Airframe systems should be shown to comply with CS 25.1309 in accordance with ~~s~~Sections 7 and 8 of ~~c~~Chapter II and with Appendix 2 to this AMC.

(2) The propulsion systems should be shown to comply with CS 25.901.

(i) Engineering and operational judgement, applied in accordance with the guidance ~~outlined~~ provided in ~~s~~Section 6 and Appendix 1, should be used to show that the propulsion system can achieve the desired level of reliability.

(ii) Contained engine failure, cascading failures, consequential damage or failure of remaining systems or equipment should be assessed in accordance with CS 25.901.

(iii) It should be shown during the type design evaluation that the approved engine limits at all approved power settings will not be exceeded when conducting an extended duration single-engine operation during the diversion in all expected environmental conditions. The assessment should account for the effects of additional engine loading demands (e.g.~~,~~ anti-icing, electrical, etc.) which may be required during the single-engine flight phase associated with the diversion.

(3) The safety impact of an uncontained engine failure should be assessed in accordance with CS 25.903.

(4) The APU installation, if required for extended-range operations, should meet the applicable CS-25 provisions (Subpart J, APU) and any additional requirements necessary to demonstrate its ability to perform the intended function as specified by ~~the Agency~~ EASA following a review of the applicant's data. If certain extended-range operation may necessitate in-flight start and run of the APU, it must be substantiated that the APU has adequate capability and reliability for that operation.

The APU should demonstrate the required in-flight start reliability throughout the flight envelope (compatible with overall safety objective but not less than 95 %) taking account of all approved fuel types and temperatures. An acceptable procedure for starting and running the APU (e.g. descent to allow start) may be defined in order to demonstrate compliance with ~~to~~ the required in-flight start reliability. If this reliability cannot be demonstrated, it may be necessary to require continuous operation of the APU.

(5) Extended duration, single-engine operations should not require exceptional piloting skills and/or crew co-ordination. Considering the degradation of the performance of the aeroplane type with an engine inoperative, the increased flight crew workload, and the malfunction of remaining systems and equipment, the impact on flight crew procedures should be minimised.

Consideration should also be given to the effects on the crew's and passengers' physiological needs (e.g.~~,~~ cabin temperature control), when continuing the flight with an inoperative engine or one or more inoperative airframe system(s).

The provision of essential services to ensure the continued safety of the aeroplane and safety of the passengers and crew, particularly during very long diversion times with depleted/degraded systems, should be assessed. The applicant should provide a list of aircraft system functions considered to be ~~as~~ necessary to perform a safe ETOPS flight. The applicants should consider the following examples:

(i) Flight deck and cabin environmental systems integrity and reliability

(ii) The avionics/cooling and consequent integrity of the avionic systems

(iii) Cargo hold fire suppression capacity and integrity of any smoke/fire alerting system

(iv) Brake accumulator or emergency braking system capacity/integrity

(v) Adequate capacity of all-time dependent functions

(vi) Pressurisation system integrity/reliability

(vii) Oxygen system integrity/reliability/capacity, if the maximum approved diversion time is based on the oxygen system capability

(viii) Integrity/reliability/capacity of back-up systems (e.g. electrical, hydraulic)

(ix) Fuel system integrity and fuel accessibility. Fuel consumption with engine failure and/or other system failures (see paragraph (11))

(x) Fuel quantity and fuel used, indications and alerts (see paragraph (10))

(6) It should be demonstrated for extended duration single-engine operation, that the remaining power (electrical, hydraulic, pneumatic) will continue to be available at levels necessary to permit continued safe flight and landing, and to provide those services necessary for the overall safety of the passengers and crew.

Unless it can be shown that cabin pressure can be maintained on single-engine operation at the altitude necessary for continued flight to an ETOPS en-route alternate aerodrome, oxygen should be available to sustain the passengers and crew for the maximum diversion time.

(7) In the event of any single failure, or any combination of failures not shown to be Extremely Improbable, it should be shown that electrical power is provided for essential flight instruments, warning systems, avionics, communications, navigation, required route or destination guidance equipment, supportive systems and/or hardware and any other equipment deemed necessary for extended-range operation to continue safe flight and landing at an ETOPS en-route alternate aerodrome. Information provided to the flight crew should be of sufficient accuracy for the intended operation.

Functions to be provided may differ between aeroplanes and should be agreed with ~~the Agency~~ EASA. These should normally include:

(i) attitude information;

(ii) adequate radio communication (including the route specific long-range communication equipment as required by the applicable operational regulations) and intercommunication capability;

(iii) adequate navigation capability (including route specific long-range navigation equipment as required by the applicable operational regulations and weather radar);

(iv) adequate cockpit and instrument lighting, emergency lighting and landing lights;

(v) sufficient captain and first officer instruments, provided cross-reading has been evaluated;

(vi) heading, airspeed and altitude including appropriate pitot/static heating;

(vii) adequate flight controls including auto-pilot;

(viii) adequate engine controls, and restart capability with critical type fuel (from the stand-point of flame out and restart capability) and with the aeroplane initially at the maximum relight altitude;

(ix) adequate fuel supply system capability including such fuel boost and fuel transfer functions that may be necessary;

(x) adequate engine instrumentation;

(xi) such warning, cautions, and indications as are required for continued safe flight and landing;

(xii) fire protection (cargo, APU and engines);

(xiii) adequate ice protection including windshield de-icing;

(xiv) adequate control of cockpit and cabin environment including heating and pressurisation; and,

(xv) ATC transponder.

Note: For 90 minutes or less ETOPS operations, the functions to be provided must satisfy the requirements of CS 25.1351(d)(2) as interpreted by AMC 25.1351(d)~~(4) and (5)~~.

(8) Three or more reliable and independent electrical power sources should be available. As a minimum, following failure of any two sources, the remaining source should be capable of powering the items specified in paragraph (7). If one or more of the required electrical power sources are provided by an APU, hydraulic system, or ram air turbine, the following criteria apply as appropriate:

(i) The APU, when installed, should meet the criteria in paragraph (4).

(ii) The hydraulic power source should be reliable. To achieve this reliability, it may be necessary to provide two or more independent energy sources (e.g.~~,~~ bleed air from two or more pneumatic sources).

(iii) The ram air turbine (RAT) should be demonstrated to be sufficiently reliable in deployment and use. The RAT should not require engine-dependent power for deployment.

If one of the required electrical power sources is provided by batteries, the following criteria apply:

(iv) When one of the ~~3~~ three independent electrical power sources is time-limited (e.g. batteries), such power source should have a capability to enable the items required in paragraph (7) to be powered for continued flight and landing to an ETOPS en-route alternate aerodrome and it will be considered ~~as~~ to be a time-limited system in accordance with paragraph (12).

(9) For ETOPS approvals above 180 minutes, in addition to the criteria for electrical power sources specified in paragraph (8) above, the following criteria should also be applied:

(i) Unless it can be shown that the failure of all three ~~3~~ independent power sources required by paragraph (8) above is extremely improbable, following failure of these three ~~3~~ independent power sources, a fourth independent power source should be available that is capable of providing power to the essential functions referred to in paragraph (7) for continued safe flight and landing to an adequate ETOPS en-route alternate aerodrome

(ii) If the additional power source is provided by an APU, it should meet the criteria in paragraph (4).

(iii) If the additional power source is provided by a hydraulic system or ram air turbine, the provisions of paragraph (8) apply.

(10) It should be shown that adequate status monitoring information and procedures on all ETOPS significant systems are available for the flight crew to make pre-flight, in-flight go/no-go and diversion decisions.

Adequate fuel quantity information should be available to the flight crew, including alerts, and advisories, that consider the fuel required to complete the flight, abnormal fuel management or transfer between tanks, and possible fuel leaks in the tanks, the fuel lines and other fuel system components and the engines.

(11) Fuel system

(i) The aeroplane fuel system should provide fuel pressure and flow to the engine(s) in accordance with CS 25.951 and 25.955 for any fuel pump power supply failure condition not shown to be extremely improbable.

(ii) The fuel necessary to complete the ETOPS mission or during a diversion should be available to the operating engine(s) under any failure condition, other ~~then~~ than fuel boost pump failures, not shown to be extremely improbable[2] (e.g. cross-feed valve failures, automatic fuel management system failures).

(12) Time-limited system

In addition to the maximum approved diversion time, diversion time may also be limited by the capacity of the cargo hold fire suppression system or other ETOPS significant time-limited systems determined by considering other relevant failures, such as an engine inoperative, and combinations of failures not shown to be extremely improbable.

Time-limited system capability, if any, must be defined and stated in the Aeroplane Flight Manual or AFM-supplement and CMP document.

(13) Operation in icing conditions

Airframe and propulsion ice protection should be shown to provide adequate capability (aeroplane controllability, etc.) for the intended operation. This should account for prolonged exposure to lower altitudes associated with the single engine diversion, cruise, holding, approach and landing.

(i) The aeroplane should be certified for operation in icing conditions in accordance with CS 25.1419.

(ii) The aeroplane should be capable of continued safe flight and landing in icing conditions at depressurisation altitudes or engine inoperative altitudes.

The extent of ice accumulation on unprotected surfaces should consider the maximum super cooled liquid water catch at one-engine inoperative and depressurisation cruise altitudes. Substantiated icing scenario(s) should be assumed to occur during the period of time when icing conditions are forecast. The icing episode(s) assumed should be agreed with ~~the Agency~~ EASA. The probability of icing longer than that assumed, and agreed for the icing episode(s), in combination with the probability of the aeroplane having to operate in icing conditions (e.g. engine in-flight ~~shut down~~ shutdown or decompression) should be shown to be extremely improbable.

(14) Solutions to achieve required reliability

The permanent solution to a problem should be, as far as possible, a hardware/design solution. However, if scheduled maintenance, replacement, and/or inspection are utilised to obtain type design approval for extended-range operation, and therefore are required in the CMP standard document, the specific maintenance information should be easily retrievable and clearly referenced and identified in an appropriate maintenance document.

(15) Engine condition monitoring

Procedures for an engine condition monitoring process should be defined and validated for ETOPS. The engine condition monitoring process should be able to determine, if an engine is no longer capable of providing, within certified engine operating limits, the maximum thrust required for a

[2] Extremely improbable is defined in CS 25.1309 and AMC to CS 25.1309.

single engine diversion. The effects of additional engine loading demands (e.g.~~,~~ anti-ice, electrical), which may be required during an engine inoperative diversion, should be accounted for.

SECTION 8: ANALYSIS OF FAILURE EFFECTS AND RELIABILITY

8.1 General

The analysis and demonstrations of airframe and propulsion system level of reliability and failure effects required by ~~s~~Section 6 and ~~s~~Section 7 should be based on the expected longest diversion time for extended-range routes likely to be flown with the aeroplane. However, in certain failure scenarios, it may be necessary to consider a shorter diversion time due to the time-limited systems.

8.2 Propulsion systems

(i) An assessment of the propulsion system's reliability for particular airframe/engine combinations should be made in accordance with ~~s~~Section 6 and Appendix 1.

(ii) The analysis should consider:

(A) effects of operation with a single-propulsion system (i.e.~~,~~ high-power demands including extended use of MCT and bleed requirements, etc.) and include possible damage that could result from failure of the first propulsion system.

(B) effects of the availability and management of fuel for propulsion system operation (i.e.~~,~~ cross-feed valve failures, fuel mismanagement, ability to detect and isolate leaks, etc.).

(C) effects of other failures, external conditions, maintenance and crew errors, that could jeopardise the operation of the remaining propulsion system, should be examined.

(D) effect of inadvertent thrust reverser deployment, if not shown to be extremely improbable (includes design and maintenance).

8.3 Airframe systems

An assessment of the airframe system's reliability for particular airframe/engine combinations should be made in accordance with ~~s~~Section 7 and Appendix 2.

The analysis should consider:

(i) Hydraulic power and flight control

An analysis should be carried out taking into account the criteria detailed in ~~paragraph~~ ~~s~~Section 7 paragraph (6).

Consideration of these systems may be combined, since many commercial aeroplanes have full hydraulically powered controls. For aeroplanes with all flight controls being hydraulically powered, evaluation of hydraulic system redundancy should show that single failures or failure combinations, not shown to be extremely improbable, do not preclude continued safe flight and landing at an ETOPS en-route alternate aerodrome. As part of this evaluation, the loss of any parts of the hydraulic systems and any engine should be assumed to occur unless it is established during failure evaluation that there are no sources of damage or the location of the damage sources are such that this failure condition will not occur.

Note: For 75 minutes or less ETOPS approval, additional analysis to show compliance with ~~s~~Section 7 will not be required for airframe systems, where for basic (non-ETOPS) type design approval compliance with CS 25.1309, or its equivalent, has already been shown.

(ii) Services provided by electrical power

An analysis should show that the criteria detailed in ~~s~~Section 7 paragraphs (6), (7) and (8) are satisfied taking into account the exposure times established in paragraph (1).

Note1: For 75 minutes or less ETOPS approval, additional analysis to show compliance with ~~s~~Section 7 will not be required for airframe systems, where for basic (non-ETOPS) type design approval (TDA), compliance with CS 25.1309, or its equivalent, has already been shown.

Note 2: For ETOPS approval above 180 minutes, the analysis should also show that the criteria detailed in ~~s~~Section 7 paragraph (9) are satisfied.

(iii) Equipment cooling

An analysis should establish that the equipment (including avionics) necessary for extended-range operation has the ability to operate acceptably following failure modes in the cooling system not shown to be extremely improbable. Adequate indication of the proper functioning of the cooling system should be demonstrated to ensure system operation prior to dispatch and during flight.

Note: For 75 minutes or less ETOPS approval, additional analysis to show compliance with ~~paragraph~~ ~~s~~Section 7 will not be required for airframe systems, where for basic (non-ETOPS) type design approval (TDA), compliance with CS 25.1309, or its equivalent, has already been shown.

(iv) Cargo compartment

It should be shown that the cargo compartment design and fire protection system capability (where applicable) is consistent with the following:

(A) Design

The cargo compartment fire protection system integrity and reliability should be suitable for the intended operation considering fire detection sensors, liner materials, etc.

(B) Fire protection

The capacity/endurance of the cargo compartment fire suppression system should be established.

(v) Cabin pressurisation

Authority/~~Agency~~EASA-approved aeroplane performance data should be available to verify the ability to continue safe flight and landing after loss of pressure and subsequent operation at a lower altitude (see also ~~s~~Section 7 paragraph (6)).

(vi) Cockpit and cabin environment

The analysis should show that an adequate cockpit and cabin environment is preserved following all combinations of propulsion and electrical system failures which are not shown to be extremely improbable, e.g. when the aeroplane is operating on standby electrical power only.

Note: For 75 minutes or less ETOPS approval, additional analysis to show compliance with ~~s~~Section 7 will not be required for airframe systems, where for basic (non-ETOPS) type design approval (TDA), compliance with CS 25.1309, or its equivalent, has already been shown.

SECTION 9: ASSESSMENT OF FAILURE CONDITIONS

In assessing the fail-safe features and effects of failure conditions, account should be taken of:

(1) The variations in the performance of the system, the probability of the failure(s), the complexity of the crew action.

(2) Factors alleviating or aggravating the direct effects of the initial failure condition, including consequential or related conditions existing within the aeroplane which may affect the ability of the crew to deal with direct effects, such as the presence of smoke, aeroplane accelerations, interruption of air-to-ground communication, cabin pressurisation problems, etc.

(3) A flight test should be conducted by the (S)TC holders and witnessed by ~~the Agency~~ EASA to validate expected aeroplane flying qualities and performance considering propulsion system failure, electrical power losses, etc. The adequacy of remaining aeroplane systems and performance and flight crew ability to deal with the emergency, considering remaining flight deck information, will be assessed in all phases of flight and anticipated operating conditions. Depending on the scope, content, and review by ~~the Agency~~ EASA of the (S)TC holders database ~~data base~~, this flight test could also be used as a means for approving the basic aerodynamic and engine performance data used to establish the aeroplane performance identified in ~~c~~Chapter III.

(4) Safety assessments should consider the flight consequences of single or multiple system failures leading to a diversion, and the probability and consequences of subsequent failures or exhaustion of the capacity of time-limited systems that might occur during the diversion.

Safety assessments should determine:

(i) The effect of the initial failure condition on the capability of the aeroplane to cope with adverse conditions at the diversion airport, and

(ii) The means available to the crew to assess the extent and evolution of the situation during a prolonged diversion.

The aeroplane flight manual and the flight crew warning and alerting and display systems should provide clear information to enable the flight crew to determine when failure conditions are such that a diversion is necessary.

The assessment of the reliability of propulsion and airframe systems for a particular airframe/engine combination will be contained in the ~~Agency~~ EASA-approved Aeroplane Assessment Report. In the case ~~the Agency~~ EASA is validating the approval issued by a third-country certification authority, the report may incorporate the assessment report established by the latter.

Following approval of the report, the propulsion and airframe system recommendations will be included in an ~~Agency~~EASA-approved CMP document that establishes the CMP standard requirements for the candidate engine or airframe/engine combination. This document will then be referenced in the Operation Specification and the Aircraft Flight Manual or AFM-Supplement.

SECTION 10: ISSUE OF THE ETOPS TYPE DESIGN APPROVAL

Upon satisfactory completion of the aeroplane evaluation through an engineering inspection and test programme consistent with the type certification procedures of ~~the Agency~~ EASA and sufficient in-service experience data (see Appendices~~x~~ 1 and ~~&~~ 2):

(1) The type design approval, the maximum approved diversion Time and demonstrated capability of any time-limited systems will be reflected in the approved AFM or AFM-Supplement, and the aeroplane and engine type certification data sheet or supplemental type certificate which contain directly or by reference the following pertinent information, as applicable:

(i) special limitations (if necessary), including any limitations associated with a maximum diversion time established in accordance with ~~s~~Section 8 paragraph (1) and time-limited systems (for example, the endurance of cargo hold fire suppression systems);

(ii) additional markings or placards (if required);

(iii) revision to the performance section of the AFM to include the data required by Appendix 4 paragraph 10;

(iv) the airborne equipment, installation, and flight crew procedures required for extended-range operations;

(v) description or reference to the CMP document containing the approved aeroplane standards for extended-range operations;

(vi) a statement to the effect that:

'~~"~~The type design, systems reliability and performance of the considered ~~airplane~~aeroplane/engine models combinations have been evaluated by ~~the Agency~~ EASA in accordance with CS-25, CS-E and AMC 20-6 and have been found suitable for ETOPS operations when configured, maintained and operated in accordance with this document. This finding does not constitute an approval to conduct ETOPS operations.'~~"~~

(2) The engine ETOPS type design approval and maximum approved diversion time will be reflected in the engine type certification data sheet or supplemental type certificate which contain directly or by referencing the following pertinent information, as applicable:

(i) special limitations (if necessary), including any limitations associated with the maximum approved diversion time should be established;

(ii) additional markings or placards (if required);

(iii) description or reference to a document containing the approved engine configuration.

SECTION 11: CONTINUED AIRWORTHINESS OF THE ETOPS TYPE DESIGN APPROVAL

(1) ~~the Agency~~ EASA will include the consideration of extended-range operation in its normal surveillance and design change approval functions.

(2) The (S)TC holders whose approval includes a type design ETOPS approval, as well as ~~the Agency~~ EASA, should periodically and individually review the in-service reliability of the airframe/engine combination and of the engine. Further to these reviews and each time that an urgent problem makes it necessary, in order to achieve and maintain the desired level of reliability and therefore the safety of ETOPS, ~~the Agency~~ EASA may:

- require that the type design standard be revised~~,~~; for example, by the issuance of an airworthiness directive, or
- issue an emergency conformity information[3].

[3] See EASA Airworthiness Directive Policy reference C.Y001-01 (28.07.08).

(3) The Reliability Tracking Board will periodically check that the airframe/propulsion system reliability requirements for extended-range operation are achieved or maintained. For mature ETOPS products, the RTB may be replaced by the process to monitor their reliability as defined in Appendix 1, sSection 6.b and Appendix 2, sSection 5.c.

Note: Periodically means in this context 2 two years.

(4) Any significant problems which adversely affect extended-range operation will be corrected. Modifications or maintenance actions to achieve or maintain the reliability objective of extended-range operations for the airframe/engine combination will be incorporated into the CMP document. the Agency EASA will co-ordinate this action with the affected (S)TC holder.

(5) The CMP document which establishes the suitability of an engine or airframe/engine combination for extended-range operation defines the minimum standards for the operation.

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, or with a maximum take-off mass of 45 360 kg 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 and a maximum take-off mass of less than 45 360 kg, in excess of 180 minutes at the approved one-engine-inoperative speed (in still air) from an adequate aerodrome.

SECTION 2: COMPETENT AUTHORITY

The competent authority Competent Authority for the issue of an ETOPS operational approval to an operator is the authority that has issued its air operator certificate.

Nevertheless, as the operational approval requires the operator to comply with the continuing airworthiness requirements of Annex Appendix 8 to of this AMC, the operator has to ensure that the specific ETOPS elements related to continuing airworthiness are approved by the competent authority Competent Authority designated in Annex I (Part-M) to Regulation (EC) 2042/2003 (EU) No 1321/2014.

SECTION 3: APPLICABLE OPERATIONAL REQUIREMENTS

This chapter details the approval process required for ETOPS in accordance with the operational requirements[4].

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 pre-requisite 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 criteria defined in this section permit approval of ETOPS operations up to 180 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.

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 competent authority

5.1 Application phase

The operator should submit an accelerated ETOPS operations approval plan to the authority ~~six~~ ~~(~~6~~)~~ months before the proposed start of ETOPS. This time will permit the competent authority 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. ~~t~~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 ~~six~~ 6 months before the proposed start of ETOPS and should continue until at least ~~six~~ 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~~ing~~ Accelerated ETOPS operations approval should also demonstrate to the competent authority that it has established an ETOPS process that includes the following ETOPS elements:

1. Airframe/engine combination and engine compliance with ~~to~~ 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~~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~~ 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 or other competent 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 manageing 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 competent authority 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~~ing~~ 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 ~~shut down~~ (IFSD), unscheduled engine removals, or any other significant operational events;

4. provide periodic process validation reports to the competent authority (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 competent authority:

1. Validation periods, including start dates and proposed completion dates;
2. Definition of aeroplane to be used in the validation (the Llist 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 competent authority ~~Competent Authority~~ 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 competent authority

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

The approval issued by the competent authority ~~Competent Authority~~ for ETOPS up to 180 minutes should be based on the information required in Appendix 3 sSection 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 competent authority 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 competent authority, 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~~ing~~ 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 competent authority 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 ~~his~~ 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 establishment of an IFSD rate objective in accordance with Appendix 1 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 ~~of~~ 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 competent ~~A~~authority 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 competent authority

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

The approval issued by the competent authority ~~Competent Authority~~ for ETOPS should specifically include provisions as described in Appendix 3 ~~s~~Section 4.

SECTION 7: ETOPS APPROVAL CATEGORIES

There are ~~4~~ 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 ~~and a maximum take-off mass less than 45 360 kg~~

An operator that seeks~~ing~~ 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.

If the airframe/engine combination does not yet have a type design approval for at least 90 minutes diversion time, the aircraft should satisfy the relevant ETOPS design requirements.

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) Additional considerations for aircraft with 120 minutes maximum approved diversion time

In the case of an aircraft approved for 120 minutes maximum approved diversion time, an operator may request an increase in the operator's approved diversion time for specific routes provided:

1. The requested operator's approved diversion time does not exceed either:
   - 115 % of the maximum approved diversion time, or
   - the time-limited system capability minus 15 minutes.
2. The aeroplane fuel carriage supports the requested Operator's Approved Diversion Time.

3. It can be shown that the resulting routing will not reduce the overall safety of the operation.

Such increases will require:

(A) ~~the Agency~~ EASA to assess overall type design including time-limited systems, demonstrated reliability; and

(B) the development of an appropriate MEL related to the diversion time required.

ii) Additional considerations for aircraft with 180 minutes maximum approved diversion time

In the case of an aircraft certified for 180 minutes maximum approved diversion time, an operator may request an increase in the operator's approved diversion time for specific routes provided:

1. The requested operator's approved diversion time does not exceed either:

   - 115 % of the maximum approved diversion time, or
   - the time-limited system capability minus 15 minutes

2. The aeroplane fuel carriage supports the requested Operator's Approved Diversion Time diversion time.

3. It can be shown that the resulting routing will not reduce the overall safety of the operation.

Such increases will require:

(A) ~~the Agency~~ EASA to assess overall type design including time-limited systems, demonstrated reliability; and

(B) the development of an appropriate MEL related to the diversion time required.

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, ~~to ensure~~ 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 ~~of~~ 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

(i) Type design

The airframe/engine combination should have the appropriate Type Design approval for the requested maximum diversion times in accordance with the criteria in CS 25.1535 and ~~c~~Chapter II 'Type design approval considerations' of this AMC.

(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 ~~s~~Section 5.

SECTION 8: ETOPS OPERATIONS MANUAL SUPPLEMENT

The ETOPS ~~operations manual~~ Operations Manual supplement or its equivalent material in the Operations Manual ~~operations manual~~, and any subsequent amendments, are subject to approval by the competent authority ~~Competent Authority~~.

The ~~A~~authority 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 ~~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-Rroute 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 competent authority Competent Authority 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 Appendices 1, 2 and 8. As with all other operations, the competent authority Competent Authority should 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 as provided in Appendix 1, 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 appropriate competent authority Competent Authority should 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 appropriate Aauthority should alert the Ccertification Aauthority when a special evaluation is initiated and make provisions for their participation.

Appendix 1 to AMC20-6B — Propulsion system reliability assessment

1. ASSESSMENT PROCESS

To establish, by utilising service experience, whether a particular airframe/engine combination has satisfied the propulsion systems reliability requirements for ETOPS, an engineering assessment will be made by ~~the Agency~~ EASA, using all pertinent propulsion system data. To accomplish the assessment, ~~the Agency~~ EASA will need world fleet data (where available), and data from various sources (the operator, the engine and aeroplane (S)TC holder) which should be extensive enough and of sufficient maturity to enable ~~the Agency~~ EASA to assess with a high level of confidence, using engineering and operational judgement and standard statistical methods where appropriate, that the risk of total power loss from independent causes is sufficiently low. ~~the Agency~~ EASA will state whether or not the current propulsion system reliability of a particular airframe/engine combination satisfies the relevant criteria. Included in the statement, if the operation is approved, will be the engine build standard, propulsion system configuration, operating condition and limitations required to qualify the propulsion system as suitable for ETOPS.

Alternatively, where type design approval for Early ETOPS is sought at entry into service, the engineering assessment can be based on substantiation by analysis, test, in-service experience or other means, to show that the propulsion system will minimise failures and malfunctions and will achieve an IFSD rate that is compatible with the specified safety target associated with total loss of thrust.

If an approved engine CMP is maintained by the responsible engine ~~A~~authority and is duly referenced on the engine Type Certificate Data Sheet or STC, then this shall be made available to ~~the Agency~~ EASA conducting the aeroplane propulsion system reliability assessment. Such a CMP shall be produced taking into account all the requirements of ~~c~~Chapter II and should be incorporated or referenced in the aeroplane CMP.

2. RELIABILITY VALIDATION METHODS

There are two extremes in the ETOPS process with respect to maturity; one is the demonstration of stable reliability by the accumulation of in-service experience and the other is by a programme of design, test and analysis, agreed between the (S)TC holders and ~~the Agency~~ EASA. The extent to which a propulsion system is a derivative of previous propulsion systems used on an ETOPS approved aeroplane ~~airplane~~ is also a factor of the level of maturity. When considering the acceptability of a propulsion system, maturity should be assessed not only in terms of total fleet hours but also taking account of fleet leader time over a calendar time and the extent to which test data and design experience can be used as an alternative.

a. *Service experience*

There is justification for the view that modern propulsion systems achieve a stable reliability level by ~~100,000~~ 100 000 engine hours for new types and ~~50,000~~ 50 000 engine hours for derivatives. ~~3,000~~ 3 000 to ~~4,000~~ 4 000 engine hours ~~is~~ are considered to be the necessary time in service for a specific unit to indicate problem areas.

Normally, the in-service experience will be:

(1) For new propulsion systems: ~~100,000~~ 100 000 engine hours and 12 months service. Where experience on another aeroplane is applicable, a significant portion of the ~~100,000~~ 100 000 engine hours should normally be obtained on the candidate aeroplane.~~;~~

On a case-by-case basis, relevant test and design experience, and maximum diversion time requested, could be taken into account when arriving at the in-service experience required.~~;~~

(2) For derivative propulsion systems: ~~50,000~~ 50 000 engine hours and 12 months service. These values may vary according to the degree of commonality. To this end, in determining the derivative status of a propulsion system, consideration should be given to technical criteria referring to the commonality with the previous propulsion system used on an ETOPS approved aeroplane. Prime areas of concern include:

(i) Turbomachinery;
(ii) Controls and accessories and control logic;
(iii) Configuration hardware (piping, cables, etc.);
(iv) Aeroplane to engine interfaces and interaction:

(A) Fire;
(B) Thrust reverser;
(C) Avionics;
(D) etc.

The extent to which the in-service experience might be reduced would depend upon the degree of commonality with the previous propulsion system used on an ETOPS approved aeroplane using the above criteria and would be decided on a case-by-case basis.

Also on a case-by-case basis, relevant test and design experience and maximum diversion time requested could be taken into account when arriving at the in-service experience required.

Thus, the required experience to demonstrate propulsion system reliability should be determined by:

(i) The extent to which previous service experience with a common propulsion system used on an ETOPS approved aeroplane system~~s~~ can be considered;

(ii) ~~To what extent~~ The extent to which compensating factors, such as design similarity and test evidence, can be used.~~;~~

~~(iii) The two preceding considerations would then determine the amount of service experience needed for a particular propulsion system proposed for ETOPS.~~

The two preceding considerations would then determine the amount of service experience needed for a particular propulsion system proposed for ETOPS.

These considerations would be made on a case-by-case basis and would need to provide a demonstrated level of propulsion system reliability in terms of IFSD rate. See paragraph 3 'Risk Management and Risk Model'.

(3) Data required for the assessment

(i) A list of all engine shutdown events for all causes (excluding normal training events). The list should provide the following for each event:

(A) date;

(B) airline;

(C) aeroplane and engine identification (model and serial number);

(D) power-unit configuration and modification history;

(E) engine position;

(F) symptoms leading up to the event, phase of flight or ground operation;

(G) weather/environmental conditions and reason for shutdown and any comment regarding engine restart potential;

(ii) All occurrences where the intended thrust level was not achieved, or where crew action was taken to reduce thrust below the normal level (for whatever reason):;

(iii) Unscheduled engine removals/shop visit rates;

(iv) Total engine hours and aeroplane cycles;

(v) All events should be considered to determine their effects on ETOPS operations;

(vi) Additional data as required;

(vii) ~~the Agency~~ EASA will also consider relevant design and test data.

b. *Early ETOPS*

(1) Acceptable early ETOPS certification plan

Where type design approval for early ETOPS is sought at the first entry into service, the engineering assessment can be based on substantiation by analysis, test, in-service experience, CS-E 1040 compliance or other means to show that the propulsion system will minimise failures and malfunctions, and will achieve an IFSD rate that is compatible with the specified safety target associated with catastrophic loss of thrust. An approval plan, defining the early ETOPS reliability validation tests and processes, must be submitted by the applicant to ~~the Agency~~ EASA for agreement. This plan must be implemented and completed to the satisfaction of ~~the Agency~~ EASA before an ETOPS type design approval will be granted for a propulsion system.

(2) Propulsion system validation test

The propulsion system for which approval is being sought should be tested in accordance with the following schedule. The propulsion system for this test should be configured with the aeroplane installation nacelle and engine build-up hardware representative of the type certificate standards.

Tests of simulated ETOPS service operation and vibration endurance should consist of ~~3,000~~ 3 000 representative service start-stop cycles (take-off, climb, cruise, descent, approach, landing and thrust reverse), plus three simulated diversions at maximum continuous thrust for the maximum approved diversion time for which ETOPS eligibility is sought. These diversions are to be approximately evenly distributed over the cyclic duration of the test, with the last diversion to be conducted within 100 cycles of the completion of the test.

This test must be run with the high speed and low speed main engine rotors unbalanced to generate at least 90 % ~~percent~~ of the applicant's recommended maintenance vibration levels. Additionally, for engines with three main engine rotors, the intermediate speed rotor must be unbalanced to generate at least 90 %~~percent~~ of the applicant's recommended acceptance vibration level. The vibration level shall be defined as the peak level seen during a slow acceleration/deceleration of the engine across the operating speed range. Conduct the vibration survey at periodic intervals throughout the 3 000-cycle test. The average value of the peak vibration level observed in the vibration surveys must meet the 90 % minimum requirement. Minor adjustments in the rotor unbalance (up or down) may be necessary as the test progresses in order to meet the required average vibration level requirement. Alternatively~~,~~ to a method acceptable to ~~the Agency~~ EASA, an applicant may modify their test to accommodate a vibration level marginally less than 90 % or greater than 100 % of the vibration level required in lieu of adjusting rotor unbalance as the test progresses.

Each one hertz (60 rpm) bandwidth of the high-speed rotor service start-stop cycle speed range (take-off, climb, cruise, descent, approach, landing and thrust reverse) must be subjected to $3x10^{6}$ vibration cycles. An applicant may conduct the test in any rotor speed step increment up to 200 rpm as long as the service start-stop cycle speed range is covered. For a 200-rpm step, the corresponding vibration cycle count is to be 10 million cycles. In addition, each one hertz bandwidth of the high-speed rotor transient operational speed range between flight idle and cruise must be subjected to $3x10^{5}$ vibration cycles. An applicant may conduct the test in any rotor speed step increment up to 200 rpm as long as the transient service speed range is covered. For a 200-rpm step, the corresponding vibration cycle count is to be 1 million cycles.

At the conclusion of the test, the propulsion system must be:

(i) Visually inspected according to the applicant’s on-wing inspection recommendations and limits.

(ii) Completely disassembled and the propulsion system hardware must be inspected in accordance with the service limits submitted in compliance with relevant instructions for continued airworthiness. Any potential sources of in-flight shutdown, loss of thrust control, or other power loss encountered during this inspection must be tracked and resolved in accordance with paragraph 5 of this Appendix 1.

3. RISK MANAGEMENT AND RISK MODEL

Propulsion systems approved for ETOPS must be sufficiently reliable to assure that defined safety targets are achieved.

a. For ETOPS with a maximum approved diversion time of 180 minutes or less

An early review of information for modern fixed-wing jet-powered aircraft shows that the rate of fatal accidents for all causes is in the order of $0{\cdot}3 \times 10^{-6}$ per flying hour. The reliability of aeroplane types approved for extended-range operation should be such that they achieve at least as good an accident record as equivalent technology equipment. The overall target of $0\ 3 \times 10^{-6}$ per flying hour has therefore been chosen as the safety target for ETOPS approvals up to 180 minutes.

When considering safety targets, an accepted practice is to allocate appropriate portions of the total to the various potential contributing factors. By applying this practice to the overall target of $0{\cdot}3 \times 10^{-6}$ per flying hour, in the proportions previously considered appropriate, the probability of a catastrophic accident due to complete loss of thrust from independent causes must be no worse than $0{\cdot}3 \times 10^{-8}$ per flying hour.

Propulsion system related accidents may result from independent cause events but, based on historical evidence, result primarily from events such as uncontained engine failure events, common cause events, engine failure plus crew error events, human error related events and other. The majority of these factors are not specifically exclusive to ETOPS.

Using an expression developed by ICAO, (ref. AN-WP/5593 dated 15/2/84), for the calculation of engine in-flight shutdown rate, together with the above safety objective and accident statistics, a relationship between target engine in-flight shutdown rate for all independent causes and maximum diversion time has been derived. This is shown in Figure 1.

In order that type design approval may be granted for extended operation range, it will be necessary to satisfy ~~the Agency~~ EASA that after application of the corrective actions identified during the engineering assessment (see Appendix 1, ~~s~~Section 4: ENGINEERING ASSESSMENT. CRITERIA FOR ACCEPTABLE RELIABILITY VALIDATION METHODS), the target engine in-flight shutdown rates will be achieved. This will provide assurance that the probability objective for loss of all thrust due to independent causes will be met.

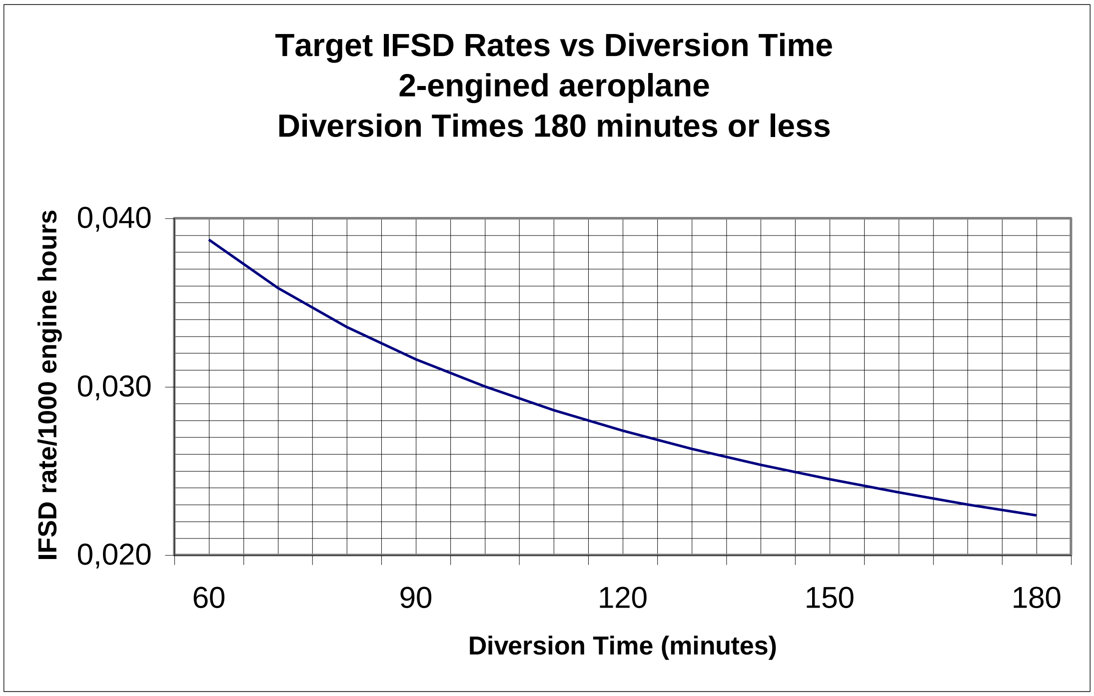

Figure 1

b. *For ETOPS with a maximum approved diversion time of ~~greater~~ longer than 180 minutes*

The propulsion systems IFSD rate target should be compatible with the objective that the catastrophic loss of thrust from independent causes is no worse than extremely improbable, based on maximum ETOPS flight duration and maximum ETOPS rule time.

For ETOPS with maximum approved diversion times longer than 180 minutes, to meet this objective, the powerplant installations must comply with the safety objectives of CS 25.1309;~~,~~ the goal should be that the catastrophic loss of thrust from independent causes should be extremely improbable (see AMC 25.1309). The defined target for ETOPS approvals with diversion times of 180 minutes or less, for catastrophic loss of thrust from independent causes, is 0.3×10^{-8}/hr (see paragraph 3 of this Appendix). This target was based on engine IFSD rates that were higher than can be and are being achieved by modern ETOPS airframes/engines. To achieve the same level of safety for ETOPS approvals beyond 180 minutes as has been achieved for ETOPS approvals of 180 minutes or less, the propulsion system reliability IFSD rate target needs to be set and maintained at a level that is compatible with an Extremely Improbable safety objective (i.e. 1.0×10^{-9}/flight hr).

For example, a target overall IFSD rate of 0.01/1000 hr~~.~~ (engine hours) that is maintained would result in the loss of all thrust on two engine aeroplanes being extremely improbable even assuming the longest time envisaged. The risk model formula summarised for a two-engine aeroplane is:

p/flight hour = [2(Cr x{T-t}) x Mr(t)] divided by T

(1) p is the probability of a dual independent propulsion unit failure on a twin,

(2) 2 is the number of opportunities for an engine failure on a twin (2),

(3) Cr is cruise IFSD rate (0.5x overall rate), Mr is max continuous IFSD rate (2x overall rate), T is planned max flight duration in hours (departure to planned arrival airport), and t is the diversion or flight time in hours to a safe landing. IFSD rates, based on engine manufacturers' historical data from the last ~~ten~~ 10 years of modern large turbofan engines, presented to the JAA/EASA and ARAC ETOPS working groups, have shown cruise IFSD rates to be of the order of 0.5x overall rate, and the max continuous IFSD rate (estimated from engine fleet analysis) to be 2x overall rate. Then, for an IFSD goal of .010/1000EFH overall, the cruise IFSD rate is .005/1000EFH, and the max continuous rate is .020/1000EFH.

(4) Sample calculation (max flight case scenario): assume T = 20 hour max flight duration, an engine failure after 10 hours, then continued flight time required is t = 10 hours, using the ETOPS IFSD goal of .010/1000EFH or less, results in a probability of p=1 E-9/hour (i.e. meets extremely improbable safety objective from independent causes).

(5) A relationship between target IFSD rate and diversion times for two-engine aeroplanes is shown in Figure 2.

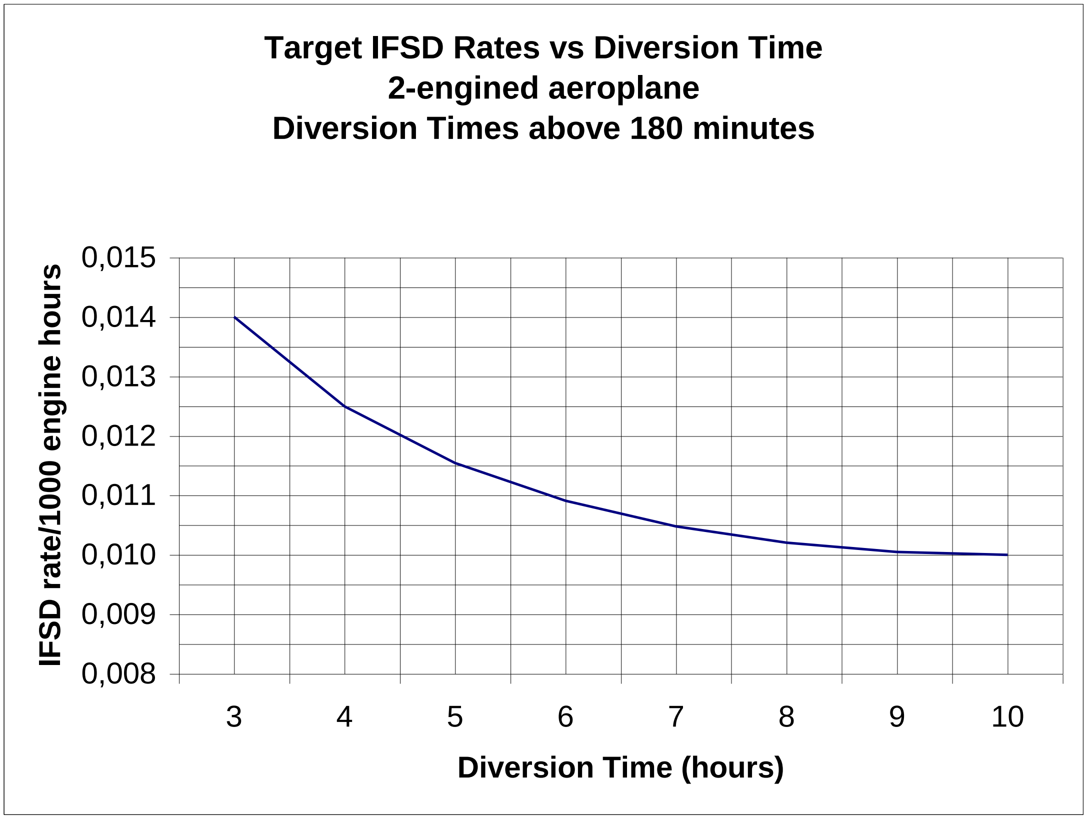

Figure 2

4. ENGINEERING ASSESSMENT CRITERIA FOR ACCEPTABLE RELIABILITY VALIDATION METHODS

The following criteria identify some areas to be considered during the engineering assessment required for either reliability validation method.

a. There are maintenance programmes, engine on-wing health monitoring programmes, and the promptness and completeness in incorporating engine service bulletins, etc.~~,~~ that influence an operator's ability to maintain a level of reliability. The data and information required will form a basis from which a world~~-~~fleet engine ~~shut down~~ shutdown rate will be established, for use in determining whether a particular airframe/engine combination complies with criteria for extended-range operation.

b. An analysis will be made on a case-by-case basis, of all significant failures, defects and malfunctions experienced in service or during testing, including reliability validation testing, for the particular airframe/engine combination. Significant failures are principally those causing or resulting in in-flight ~~shut down~~ shutdown or flameout of the engine(s), but may also include unusual ground failures and/or unscheduled removal of engines. In making the assessment, consideration should be given to the following:

(1) The type of propulsion system, previous experience, whether the power-unit is new or a derivative of an existing model, and the operating thrust level to be used after one engine shutdown;

(2) The trends in the cumulative ~~twelve~~ 12-month rolling average, updated quarterly, of in-flight shutdown rates versus propulsion system flight hours and cycles;

(3) The demonstrated effect of corrective modifications, maintenance, etc. on the possible future reliability of the propulsion system;

(4) Maintenance actions recommended and performance and their effect on propulsion system and APU failure rates;

(5) The accumulation of operational experience which covers the range of environmental conditions likely to be encountered;

(6) Intended maximum flight duration and maximum diversion in the ETOPS segment, used in the extended-range operation under consideration.

c. Engineering judgement will be used in the analysis of paragraph b. above, such that the potential improvement in reliability, following the introduction of corrective actions identified during the analysis, can be quantified.

d. The resultant predicted reliability level and the criteria developed in accordance with ~~s~~Section 3 (RISK MANAGEMENT AND RISK MODEL) should be used together to determine the maximum diversion time for which the particular airframe/engine combination qualifies.

e. The type design standard for type approval of the airframe/engine combination, and the engine, for ETOPS will include all modifications and maintenance actions for which full or partial credit is taken by the (S)TC holder and other actions required by ~~the Agency~~ EASA to enhance reliability. The schedule for incorporation of type design standard items should normally be established in the configuration, maintenance and procedures (CMP) document, for example in terms of calendar time, hours or cycles.

f. When third-country (S)TC holders' and/or third-country operators'~~s~~ data ~~are~~ is evaluated, the respective foreign ~~A~~authorities will be offered to participate in the assessment.

g. ETOPS reliability tracking board (RTB)'s findings

Once an assessment has been completed and the RTB has documented its findings, ~~the Agency~~ EASA will declare whether or not the particular airframe/engine combination and engine satisfy the relevant considerations of this AMC. Items recommended qualifying the propulsion system, such as maintenance requirements and limitations will be included in the Assessment Report (~~c~~Chapter II ~~s~~Section 10 of this AMC).

h. In order to establish that the predicted propulsion system reliability level is achieved and subsequently maintained, the (S)TC holder should submit to ~~the Agency~~ EASA an assessment of the reliability of the propulsion system on a quarterly basis. The assessment should concentrate on the ETOPS configured fleet and should include ETOPS-related events from the non-configured fleet of the subject airframe/engine combination and from other combinations utilising a related engine model.

5. EARLY ETOPS OCCURRENCES REPORTING & TRACKING

a. The holder of a (supplemental) type certificate of an engine, which has been approved for ETOPS without service experience in accordance with this AMC, should establish a system to address problems and occurrences encountered on the engine that could affect the safety of operations and timely resolution.

b. The system should contain a means for: the prompt identification of ETOPS related events, the timely notification of the event to ~~the Agency~~ EASA, proposing a resolution of the event and obtaining ~~Agency~~EASA's approval. The implementation of the problem resolution can be accomplished by way of ~~Agency~~ EASA-approved change(s) to the type design, the manufacturing process, or an operating or maintenance procedure.

c. The reporting system should be in place for at least the first ~~100,000~~ 100 000 fleet engine hours. The reporting requirement remains in place until the fleet has demonstrated a stable in-flight ~~shut-down~~ shutdown rate in accordance with the targets defined in this Appendix 1.

d. For the early ETOPS service period, an applicant must define the sources and content of the service data that will be made available to them in support of their occurrence reporting and tracking system. The content of this data should be adequate to evaluate the specific cause of all service incidents reportable under Part 21A.3A(~~c~~b), in addition to the occurrences that could affect the safety of operations, and should be reported, including:

(1) ~~I~~in-flight shutdown ~~shut-down~~ events and rates;

(2) ~~I~~inability to control the engine or obtain desired power;

(3) ~~P~~precautionary thrust reductions (except for normal troubleshooting as allowed in the aircraft flight manual);

(4) ~~D~~degraded propulsion in-flight start capability;

(5) un-commanded power changes or surges;~~.~~

(6) diversion or turn-back;

(7) failures or malfunctions of ETOPS significant systems;

(8) ~~U~~unscheduled engine removals for conditions that could result in one of the reportable items listed above.

6. CONTINUED AIRWORTHINESS OF TYPE DESIGN

For ETOPS, ~~the Agency~~ EASA will periodically review its original findings by means of a Reliability Tracking Board. In addition, the ~~Agency~~ EASA document containing the CMP standard will be revised as necessary.

Note: The reliability tracking board will usually comprise specialists from aeroplane and engine disciplines (see also Appendix 2).

Periodic meetings of the ETOPS reliability tracking board are normally frequent at the start of the assessment of a new product. The periodicity is adjusted by ~~the Agency~~ EASA upon accumulation of substantial service experience if there is evidence that the reliability of the product is sufficiently stable. The periodic meetings of the board are discontinued once an ETOPS product, or family of products, has been declared mature by ~~the Agency~~ EASA.

Note: The overall engine IFSD rate should be viewed as a world~~-~~fleet average target figure of engine reliability (representative of the airframe/engine combination being considered) and if exceeded, may not, in itself, trigger action in the form of a change to the ETOPS design standard or a reduction in the ETOPS approval status of the engine. The actual IFSD rate and its causes should be assessed with considerable engineering judgement. For example, a high IFSD rate early after the commencement of the operation may be due to the limited number of hours contributing to the high rate. There may have been only one ~~shut down~~ shutdown. The underlying causes have to be considered carefully. Conversely, a particular single event may warrant corrective action implementation, even though the overall IFSD rate objective is being achieved.

a. Mature ETOPS products

A family of ETOPS products with a high degree of similarity is considered to be ~~as~~ mature ones if:

(1) The product family has accumulated at least ~~250,000~~ 250 000 flight hours for an aeroplane family or ~~500,000~~ 500 000 operating hours for an engine family;

(2) The product family has accumulated service experience covering a comprehensive spectrum of operating conditions (e.g. cold, hot, high, and humid);

(3) Each ETOPS approved model or variant in the family has achieved the reliability objectives for ETOPS and has remained stable at or below the objectives fleet-wide for at least ~~two~~ 2 years;

New models or significant design changes may not be considered mature until they have individually satisfied the condition of paragraph 6.a above.

~~the Agency~~ EASA makes the determination of when a product or a product family is considered mature.

b. Surveillance of mature ETOPS products

The (S)TC holder of an ETOPS product which ~~the Agency~~ EASA has found mature, should institute a process to monitor the reliability of the product in accordance with the objectives defined in this Appendix 1. In case of occurrence of an event or series of events or a statistical trend that implies a deviation of the reliability of the ETOPS fleet, or a portion of the ETOPS fleet (e.g. one model or a range of serial numbers), above the limits specified for ETOPS in this AMC, the (S)TC holder should:

(1) Inform ~~the Agency~~ EASA and define a means to restore the reliability through a minor revision of the CMP document, with a compliance schedule to be agreed with ~~the Agency~~ EASA if the situation has no immediate safety impact;

(2) Inform ~~the Agency~~ EASA and propose an ad hoc ~~ad-hoc~~ follow-up by ~~the Agency~~ EASA until the concern has been alleviated or confirmed if the situation requires further assessment;

(3) Inform ~~the Agency~~ EASA and propose the necessary corrective action(s) to be mandated by ~~the Agency~~ EASA through an AD if a direct safety concern exists.

In the absence of a specific event or trend requiring action, the (S)TC holder should provide ~~the Agency~~ EASA with the basic statistical indicators prescribed in this Appendix 1 on a yearly basis.

c. Minor revision of the ETOPS CMP document

A minor revision of the ETOPS CMP document is one that contains only editorial adjustments, configurations, maintenance and procedures equivalent to those already approved by ~~the Agency~~ EASA or new reliability improvements which have no immediate impact on the safety of ETOPS flights and which are introduced as a means to control the continued compliance with the reliability objectives of ETOPS.

Minor revisions of the ETOPS CMP document should be approved by authorised signatories personnel of the (S)TC holder under the provisions of its approved design organisation handbook.

7. DESIGN ORGANISATION APPROVALS

(S)TC holders of products approved for ETOPS should hold a design organisation approval (DOA) conforming to ~~EASA~~ Part 21 ~~Part-21~~, with the appropriate terms of approval and privileges. Their approved design organisation handbook (DOH) must contain an appropriate description of the organisation and procedures covering all applicable tasks and responsibilities of ~~EASA~~ Part 21 ~~Part-21~~ and this AMC.

Appendix 2 to AMC20-6B — Aircraft systems reliability assessment

1. ASSESSMENT PROCESS

The intent of this Appendix is to provide additional clarification to sSections 7 and 8 of cChapter II of this AMC. Airframe systems are required to show compliance with CS 25.1309. To establish whether a particular airframe/engine combination has satisfied the reliability requirements concerning the aircraft systems for extended-range operations, an assessment will be made by ~~the Agency~~ EASA, using all pertinent systems data provided by the applicant. To accomplish this assessment, ~~the Agency~~ EASA will need world-fleet data (where available) and data from various sources (operators, (S)TC holder, original equipment manufacturers (OEMs)). This data should be extensive enough and of sufficient maturity to enable ~~the Agency~~ EASA to assess with a high level of confidence, using engineering and operational judgement, that the risk of systems failures during a normal ETOPS flight or a diversion, is sufficiently low in direct relationship with the consequence of such failure conditions, under the operational environment of ETOPS missions.

~~the Agency~~ EASA will declare whether or not the current system reliability of a particular airframe/engine combination satisfies the relevant criteria.

Included in the declaration, if the airframe/engine combination satisfiesy the relevant criteria, will be the airframe build standard, systems configuration, operating conditions and limitations, that are required to qualify the ETOPS significant systems as suitable for extended-range operations.

Alternatively, where type design approval for Early ETOPS is sought at first entry into service, the engineering assessment can be based on substantiation by analysis, test, in-service experience or other means to show that the airframe significant systems will minimise failures and malfunctions, and will achieve a failure rate that is compatible with the specified safety target.

2. SYSTEM SAFETY ASSESSMENT 'SSA' (INCLUDING RELIABILITY ANALYSIS)

The system safety assessment (SSA) which should be conducted in accordance with CS 25.1309 for all ETOPS significant systems should follow the steps below:

a. Conduct a (supplemental) functional hazard assessment (FHA) considering the ETOPS missions. In determining the effect of a failure condition during an ETOPS mission, the following should also be reviewed:

   (1) Crew workload over a prolonged period of time;

   (2) Operating conditions at single engine altitude;

   (3) Lesser crew familiarity with the procedures and conditions to fly to and land at diversion aerodromes.

b. Introduce any additional failure scenario/objectives necessary to comply with this AMC.

c. For compliance demonstration of ETOPS significant system reliability to CS 25.1309, there will be no distinction made between ETOPS group 1 and group 2 systems. For qualitative analysis (FHA), the maximum flight time and the maximum ETOPS diversion time should be considered. For quantitative analysis (SSA), the average ETOPS mission time and maximum ETOPS diversion time should be considered. Consideration should be given to how the particular airframe/engine combination is to be utilised, and analyse the potential route structure and city pairs available, based upon the range of the aeroplane.

d. Consider effects of prolonged time and at single engine altitude in terms of continued operation of remaining systems following failures.

e. Specific ETOPS maintenance tasks, intervals and specific ETOPS flight procedures necessary to attain the safety objectives, shall be included in the appropriate approved documents (e.g. CMP document, MMEL).

f. Safety assessments should consider the flight consequences of single or multiple system failures leading to a diversion and the probability and consequences of subsequent failures or exhaustion of the capacity of time critical systems, which might occur during the diversion.

Safety assessments should determine whether a diversion should be conducted to the nearest aerodrome or to an aerodrome presenting better operating conditions, considering:

(1) The effect of the initial failure condition on the capability of the aeroplane to cope with adverse conditions at the diversion aerodrome, and

(2) The means available to the crew to assess the extent and evolution of the situation during a prolonged diversion.

The aircraft flight manual and the flight crew warning and alerting and display systems should provide clear information to enable the flight crew to determine when failure conditions are such that a diversion is necessary.

3. RELIABILITY VALIDATION METHODS

There are two extremes in the ETOPS process with respect to maturity; one is the demonstration of stable reliability by the accumulation of in-service experience and the other is by design, analysis and test programmes, agreed between the (S)TC holders and ~~the Agency~~ EASA /the ~~A~~authority.

a. In-*service experience/systems safety assessment (SSA)*

In-service experience should generally be in accordance with that identified in Appendix 1 for each airframe/engine combination. When considering the acceptability of airframe systems for ETOPS, maturity should be assessed in terms of used technology and the particular design under review.

In performing the SSA~~'s~~, defined in paragraph 2 of this Appendix 2, particular account will be taken of the following:

(1) For identical or similar equipment to those used on other aeroplanes, the SSA failure rates should be validated by in-service experience:

(i) The amount of in-service experience (either direct or related) should be indicated for each equipment of an ETOPS significant system.

(ii) Where related experience is used to validate failure modes and rates, an analysis should be produced to show the validity of the in-service experience.

(iii) In particular, if the same equipment is used on a different airframe/engine combination, it should be shown that there is no difference in operating conditions (e.g.~~,~~ vibrations, pressure, temperature) or that these differences do not adversely affect the failure modes and rates.

(iv) If in-service experience with similar equipment on other aeroplanes is claimed to be applicable, an analysis should be produced substantiating the reliability figures used on the quantitative analysis. This substantiation analysis should include details of the differences between the similar and new equipment, details of the in-service experience of the similar equipment and details of any ‘~~"~~lessons learnt~~"~~’ from modifications introduced and included in the new equipment.

(v) For certain equipment~~,~~ (e.g.~~,~~ IDGs, TRUs, bleeds and emergency generators), this analysis may have to be backed up by tests. This should be agreed with ~~the Agency~~ EASA.

(2) For new or substantially modified equipment, account should be taken in the SSA for the lack of validation of the failure rates by service experience.

A study should be conducted to determine the sensitivity of the assumed SSA failure condition probabilities to the failure rates of the subject equipment.

Should a failure case probability be sensitive to this equipment failure rate and close to the required safety objective, particular provision precautions should be applied (e.g. temporary dispatch restrictions, inspections, maintenance procedures, crew procedures) to account for the uncertainty, until the failure rate has been appropriately validated by in-service experience.

b. *Early ETOPS*

Where type design approval for early ETOPS is sought at the first entry into service of the airframe/engine combination, the engineering assessment can be based on substantiation by analysis, test, in-service experience (the same engine or airframe with different engines) or other means, to show that the ETOPS significant systems will achieve a failure rate that is compatible with the specified safety objective. An approval plan, defining the early ETOPS reliability validation tests and processes, should be submitted by the (S)TC~~’s~~ holders to ~~the Agency~~ EASA for agreement. This certification plan should be completed and implemented to the satisfaction of ~~the Agency~~ EASA before an ETOPS type design approval will be granted.

(1) Acceptable early ETOPS approval plan

In addition to the above considerations, the following should be complied with for an early ETOPS approval:

(i) Aeroplane testing

For each airframe/engine combination that has not yet accumulated at least 15 000~~15,000~~ engine hours in service, to be approved for ETOPS, one or more aeroplanes should conduct flight testing which demonstrates that the airframe/engine combination, its components and equipment are capable for, and function properly~~,~~ during, ETOPS flights and ETOPS diversions. These flight tests may be coordinated ~~with~~, but they are not in place of flight testing required in Part 21.A.35(b)(2).

The flight test programme should include:

(A) Flights simulating actual ETOPS operation, including normal cruise altitude, step climbs and APU operation if required for ETOPS;

(B) Demonstration of the maximum normal flight duration with the maximum diversion time for which eligibility is sought;

(C) Engine inoperative maximum time diversions to demonstrate the aeroplane and propulsion system's capability to safely conduct an ETOPS diversion, including a repeat of an MCT diversion on the same engine;

(D) Non-normal conditions to demonstrate the aeroplane's capability to safely conduct an ETOPS diversion under worst-case probable system failure conditions;

(E) Diversions into representative operational diversionary airports;

(F) Repeated exposure to humid and inclement weather on the ground followed by long-range operations at normal cruise altitude;

(G) ~~The flight testing should validate~~ Validation of the adequacy of the aeroplane's flying qualities, performance and flight crew's ability to deal with the conditions of paragraphs (C)~~/~~, (D) and ~~&~~(E) above.

(H) ~~The~~ Engine-inoperative diversions ~~must be~~ evenly distributed among the number of engines ~~in the applicant's flight test programme~~ except as required by paragraph (C) above.

(I) Provisions for the test aeroplane(s) ~~must~~ to be operated and maintained using the recommended operations and maintenance manual procedures during the aeroplane demonstration test.

(J) At the completion of the aeroplane(s) demonstration testing, an operational or functional check of the ETOPS significant systems must undergo ~~an operation or functional check~~ as per the Instructions for Continued Airworthiness of CS 25.1529. The engines must also undergo a gas path inspection. These inspections are intended to identify any abnormal conditions that could result in an in-flight shutdown or diversion. Any abnormal conditions must be identified, tracked and resolved in accordance with subpart (2) below. This inspection requirement can be relaxed for ETOPS significant systems similar in design to proven models.

(K) Maintenance and operational procedures. The applicant must validate all ETOPS significant systems maintenance and operational procedures. Any problems found as a result of the validation must be identified, tracked and resolved in accordance with ~~paragraph~~ subpart (2) below.

(ii) APU testing

If an APU is required for ETOPS, one APU of the type to be certifi~~cat~~ed with the aeroplane should complete a test consisting of 3 000 equivalent aeroplane operational cycles. Following completion of the demonstration test, the APU must be disassembled and inspected. Any potential sources of in-flight start and/or run events should be identified, tracked and resolved in accordance with ~~paragraph~~ subpart (2) below.

(2) Early ETOPS occurrence reporting & tracking

(i) The holder of a (S)TC of an aeroplane which has been approved for ETOPS without service experience in accordance with this AMC, should establish a system to address problems and occurrences encountered on the airframe and propulsion systems that could affect the safety of ETOPS operations in order to ~~and~~ timely resolve~~ution~~ ~~for~~ these events.~~;~~

(ii) The system should contain a means for the prompt identification of ETOPS-related events, the timely notification of the event to ~~the Agency~~ EASA and for proposing to, and obtaining ~~Agency~~EASA's approval for the resolution of this event. The implementation of the problem resolution can be accomplished by way of an ~~Agency~~ EASA-approved change(s) to the type design, the manufacturing process, or an operating or maintenance procedure.

(iii) The reporting system should be in place for at least the first ~~100,000~~ 100 000 flight hours. The reporting requirement remains in place until the airframe and propulsion systems have demonstrated stable reliability in accordance with the required safety objectives.

(iv) If the airframe/engine combination certified is a derivative of a previously certifi~~cat~~ed aeroplane, these criteria may be amended by ~~the Agency~~ EASA, to require reporting on only those changed systems.

(v) For the early ETOPS service period, an applicant must define the sources and content of in-service data that will be made available to them in support of their occurrence reporting and tracking system. The content of this data should be adequate to evaluate the specific cause of all service incidents reportable under Part 21.A.3A(~~c~~b), in addition to the occurrences that could affect the safety of ETOPS operations and should be reported, including:

(A) In-flight shutdown events;

(B) Inability to control the engine or obtain desired power;

(C) Precautionary thrust reductions (except for normal troubleshooting as allowed in the aircraft flight manual);

(D) Degraded propulsion in-flight start capability;

(E) Inadvertent fuel loss or availability, or uncorrectable fuel imbalance in flight;

(F) Technical air turn-backs or diversions associated with an ETOPS Group 1 system;

(G) Inability of an ETOPS Group 1 system, designed to provide backup capability after failure of a primary system, to provide the required backup capability in-flight;

(H) Any loss of electrical power or hydraulic power system, during a given operation of the aeroplane;

(I) Any event that would jeopardise the safe flight and landing of the aeroplane during an ETOPS flight.

4. CONTINUING SURVEILLANCE

In order to confirm that the predicted system reliability level is achieved and maintained, the (S)TC holder should monitor the reliability of airframe ETOPS significant systems after entry into service. The (S)TC~~'s~~ holder should submit a report to ~~the Agency~~ EASA, initially on a quarterly basis (for the first year of operation) and thereafter on a periodic basis and for a time to be agreed with ~~the Agency~~ EASA. The monitoring task should include all events on ETOPS significant systems, from both the ETOPS and non-ETOPS fleet of the subject family of airframes. This additional reliability monitoring is required only for ETOPS Group 1 systems.

5. CONTINUED AIRWORTHINESS

a. Reliability Tracking Board

~~the Agency~~ EASA will periodically review its original findings by means of a reliability tracking board. In addition, the ~~Agency~~ EASA document containing the CMP standard will be revised as necessary.

Note: The reliability tracking board will usually comprise specialists from aeroplane and engine disciplines. (See also Appendix 1).

Periodic meetings of the ETOPS reliability tracking board are normally frequent at the start of the assessment of a new product. The periodicity is adjusted by ~~the Agency~~ EASA upon accumulation of substantial in-service experience if there is evidence that the reliability of the product is sufficiently stable. The periodic meetings of the board are discontinued once an ETOPS product, or family of products, has been declared mature by ~~the Agency~~ EASA.

b. Mature ETOPS products

A family of ETOPS products with a high degree of similarity is considered to be ~~as~~ mature when:

(1) The product family has accumulated at least 250 000 ~~250,000~~ flight hours for an aeroplane family;

(2) The product family has accumulated service experience covering a comprehensive spectrum of operating conditions (e.g. cold, hot, high, humid);

(3) Each ETOPS approved model or variant in the family has achieved the reliability objectives for ETOPS and has remained stable at or below the objectives fleet-wide for at least 2 ~~two~~ years.~~;~~

New models or significant design changes may not be considered mature until they have individually satisfied the conditions specified above.

~~the Agency~~ EASA makes the determination of when a product or a product family is considered mature.

c. Surveillance of mature ETOPS products

The (S)TC holder of an ETOPS product which ~~the Agency~~ EASA has found mature, should institute a process to monitor the reliability of the product in accordance with the objectives defined in this Appendix. In case of occurrence of an event, a series of events or a statistical trend that implies a deviation of the reliability of the ETOPS fleet, or a portion of the ETOPS fleet (e.g. one model or a range of serial numbers), above the limits specified for ETOPS, the (S)TC should:

(1) Inform ~~the Agency~~ EASA and define a means to restore the reliability through a Minor Revision of the CMP document, with a compliance schedule to be agreed with ~~the Agency~~ EASA if the situation has no immediate safety impact;

(2) Inform ~~the Agency~~ EASA and propose an ad hoc ~~ad-hoc~~ follow-up by ~~the Agency~~ EASA until the concern has been alleviated, or confirmed if the situation requires further assessment;

(3) Inform ~~the Agency~~ EASA and propose the necessary corrective action(s) to be mandated by ~~the Agency~~ EASA through an AD if a direct safety concern exists.

In the absence of a specific event or trend requiring action, the (S)TC holder should provide ~~the Agency~~ EASA with the basic statistical indicators prescribed in this Appendix 2 on a yearly basis.

d. Minor revision of the ETOPS CMP document

A minor revision of the ETOPS CMP document is one that contains only editorial adjustments, configurations, maintenance and procedures equivalent to those already approved by ~~the Agency~~ EASA, or new reliability improvements which have no immediate impact on the safety of ETOPS flights and which are introduced as a means to control the continued compliance with the reliability objectives of ETOPS.

Minor revisions of the ETOPS CMP document should be approved by authorised signatories of the design organisation and under the provisions of its approved design organisation handbook.

6. DESIGN ORGANISATION APPROVAL

(S)TC holders of products approved for ETOPS should hold a design organisation approval (DOA) conforming to ~~EASA~~ Part 21 ~~Part-21~~, with the appropriate terms of approval and privileges. Their approved design organisation handbook (DOH) must contain an appropriate description of the organisation and procedures covering all applicable tasks and responsibilities of ~~EASA~~ Part 21 ~~Part-21~~ and this AMC.

Appendix 3 to AMC20-6B — 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 COMPETENT AUTHORITY

The approval issued by the competent authority ~~Competent Authority~~ for ETOPS operations should 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 AMC20-6B — 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 ~~10,000~~ ft or a higher altitude if sufficient oxygen is provided in accordance with the applicable operational requirements.

(2) A f~~F~~light 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

10,000 ft or a higher altitude if sufficient oxygen is provided in accordance with the applicable operational requirements.

(3) A fFlight 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 competent authority, 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 competent authority.

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 +10ºC, or if the outside air temperature is between 0ºC and -20ºC 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 aerodromes 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: ~~f~~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~~'s~~ 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~~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~~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 AMC20-6B — 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 ~~one~~ 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 ~~one~~ 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 ~~A~~authority.

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 competent authority 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 AMC20-6B — 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 AMC20-6B — Typical ETOPS operations manual supplement

The ETOPS Operations Manual ~~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 an-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 ~~twelve~~ 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 AMC20-6B — Continuing airworthiness considerations

1. APPLICABILITY

The requirements of this Appendix apply to the continuing airworthiness management organisations (CAMOs) 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 Part-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 AMC 20-8, 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: ~~s~~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 competent authority ~~Competent Authority~~ 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 ~~S~~significant ~~S~~systems. The competent authority ~~Competent Authority~~ should assess the proposed maintenance and reliability programme's ability to maintain an acceptable level of safety for the propulsion system and the ETOPS ~~S~~significant ~~S~~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 ~~S~~significant ~~S~~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 ~~s~~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 competent authority ~~Authority~~ (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 ~~c~~Chapter III ~~s~~Section 6.3.

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~~s~~ 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 competent authority. 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 competent authority.

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 ~~organisation~~ 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 Part-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 Part-145 organisation and CAMO