Transport Canada Transports Canada

TP 6327E

Safety Criteria for Approval of Extended Range Twin-Engine Operations *(ETOPS)*

2000 Edition

Canada

FOREWORD

TP 6327, Safety Criteria For Approval of Extended Range Twin-Engine Operations (ETOPS), is published by Transport Canada Safety and Security under the authority of the Director General, Civil Aviation by the Director, Commercial and Business Aviation in co-ordination with the Director, Aircraft Certification and the Director, Maintenance and Manufacturing.

This publication has been prepared for use and guidance of Canadian air operators operating, or seeking authority to operate, two-engine aeroplanes more than 60 minutes at the one-engine-inoperative cruise speed, from an adequate airport on routes that are not wholly within Canadian Domestic Airspace.

This ETOPS document will be amended as engineering data and practical operational experience dictate. Policy and terms of reference in this publication supersede previous directives.

The Office of Primary Interest is Commercial and Business Aviation Operational Standards.

Original signed by

M.R. Preuss
Director
Commercial and Business Aviation

UPDATE

This edition supersedes the 1996 edition of the present manual, as amended up to December 1999.

Acknowledgement/Reference

Some paragraphs or statements contained in this document may be copied in whole or in part from other documents such as the *Canadian Aviation Regulations* (CARs), the *Canada Air Pilot* (CAP), the *Aeronautical Information Publication* (AIP), the FAA Advisory Circular 120-42A, the JAA Information Leaflet No. 20, Airbus or Boeing publications etc. without specific reference to the source document. The information was copied, in some cases in order to avoid perceived contradiction between documents, and in other cases, in an effort to harmonize our requirements with those of other Authorities.

Since specific reference to the source document would have served no purpose and would have likely caused clutter in the text, it was left out and replaced by this acknowledgement.

Record of Amendments

Amendment No.	Date	Pages Affected	Initials
1	February 1, 2002	26 Pages	GL
2			
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Development

This manual has been produced with the participation and co-operation of members of the Aviation industry and the following Branches of Transport Canada Civil Aviation:

Aircraft Certification, Powerplants and Emission	(AARDD)
Aircraft Certification, Fuel and Hydromechanical Systems	(AARDD)
Aircraft Certification, Avionics and Electrical Systems	(AARDD)
Aircraft Certification, Occupant Safety and Environmental Systems	(AARDD)
Aircraft Maintenance and Manufacturing, Aircraft Evaluation	(AARPD)
Aircraft Maintenance and Manufacturing, Policy Development	(AARPC)
Commercial and Business Aviation, Airline Inspection	(AARXD)
Commercial and Business Aviation, Operational Standards	(AARXB)

Definitions

The following is a list of definitions applicable in the context of this manual only. Words, such as “Airport” may be found in other publications with a different definition.

Aircraft Flight Manual

In this publication, the term *Aircraft Flight Manual* will have the same meaning as in CAR 101.01, and will be used in lieu of the terms "Airplane Flight Manual" and/or "Approved Flight Manual".

Airport

1. Adequate - for the purpose of ETOPS, an adequate airport is an airport, which the air operator and TCCA consider to be adequate, having regard to the performance requirements applicable at the expected landing weight. In particular, it should be anticipated that at the expected time of use:

   i) the airport will be available, and equipped with the necessary ancillary services, such as ATS, lighting, communications, weather reporting, navaids and emergency services; and

   ii) at least one approach aid will be available for an instrument approach.

2. Suitable - for the purpose of ETOPS, a suitable airport is an adequate airport with weather reports, forecasts or combination thereof, indicating that the weather conditions will be at or above minima as specified in this document, and field condition reports indicate that a safe landing can be accomplished during the period of intended operation.

   Note: Additional information is contained in paragraph 3.4.6 and Appendix B of this document.

Auxiliary Power Unit (APU)

A gas turbine engine intended for use as a power source for driving generators, hydraulic pumps and other aeroplane accessories and equipment and/or to provide compressed air for aeroplane pneumatic systems.

Benign Area of Operation

An area that provides numerous adequate airports, a high level of reliability and availability of communication, navigation and ATC services and facilities, and where prevailing weather conditions are stable and generally do not approach extremes in temperature, wind, ceiling, and visibility. (The Caribbean Sea meets this criteria).

Configuration, Maintenance and Procedures (CMP) Standards

A document containing the minimum requirements for the aircraft configuration including any special inspections, maintenance tasks, hardware life limits and Master Minimum Equipment List (MMEL) constraints necessary to establish and maintain the suitability of an airframe-engine combination for extended range operations.

Critical Point (CP)

A "critical point" is the point along a route which is most critical from a fuel requirement point of view, from which an aircraft can proceed toward the destination or initiate a diversion to another airport. (The CP is usually, but not always, the last ETP).

The position of the critical point can be found using the following formula:

$$\text{Distance from point A to critical point (nm)} = \frac{D \times gsA}{gsB + gsA}$$

Where:

D = total distance from point A to point B (nm)
gsA = ground speed from critical point ***to go back*** to point A
gsB = ground speed from critical point ***to proceed*** to point B

Demanding Area of Operation

An area that has one or more of the following characteristics:

1. Prevailing weather conditions can approach extremes in winds, temperature, ceiling, and visibility for prolonged period of time;

2. few alternate airports;

3. due to remote or overwater area, a high level of reliability and availability of communications, navigation, and ATC services may not exist.

Dispatch Release

The Dispatch Release of a flight occurs when the flight dispatcher approves the Operational Flight Plan, after which it is submitted to the pilot-in-command for acceptance. The dispatch release may be in the form of an Operational Flight Plan or a separate document, signed by the flight dispatcher and issued in accordance with the company operations manual.

Engine

The basic engine assembly plus its essential accessories as supplied by the engine manufacturers.

Engineering Judgment

A subjective decision required due to the complexity of an issue based upon a qualitative analysis of relevant data.

Equal Time Point (ETP)

An Equal Time Point is a point along the route which is located at the same flight time from two airports.

Extended Range (ER) or ETOPS Operations

For the purpose of this document, extended range operations are those operations conducted over a specified route that contain a point further than 60 minutes flying time at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate airport.

ER (or ETOPS) Area of Operation

The area in which an air operator is authorized to conduct a flight under ETOPS regulations. It is defined by circles centered on the adequate airports, the radius of which is the allowed maximum diversion distance (maximum diversion distance equals approved maximum diversion time multiplied by the approved one-engine-inoperative cruise speed).

ER Entry Point (EEP)

The EEP is the point on the aircraft's outbound route beyond which the aircraft is no longer continuously within 60 minutes flying time at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate airport..

ER Exit Point (EXP)

The EXP is the first point on the aircraft's inbound route where the aircraft is continuously within 60 minutes flying time at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate airport.

ER segment

The extended range segment starts at the EEP and ends at the EXP.

ER Sensitive Event

An ER sensitive event is any occurrence that could be detrimental to ER operations. This includes, but is not limited to, in-flight shutdowns; diversions or turn-backs; uncommanded power changes or surges; inability to control the engine or obtain desired power; and problems with systems critical to ETOPS operation.

Fail-Safe

Fail-safe is the design methodology upon which Airworthiness Standards for Transport Category Aeroplanes are based. It requires that the effect of failures and combinations of failures to be considered in defining a safe design.

In-Flight Shutdown (IFSD)

When an engine ceases to function in flight and is shut down, for any reason (Ex: a flameout, internal failure, crew-initiated shut-off, foreign object ingestion, icing, etc.) or power reduction which results in an unacceptable thrust loss.

Power Plant

A system consisting of an engine and all ancillary components installed on the engine prior to installation on the aeroplane to provide and control power/thrust and for the extraction of energy.

Single Engine Cruise Speed (or One-Engine-Inoperative Cruise Speed)

1. The approved one-engine-inoperative cruise speed for the intended area of operation shall be a speed, within the certified limits of the aeroplane, selected by the air operator and approved by Transport Canada Civil Aviation (TCCA).

2 The air operator shall use this speed in:

i) establishing the area of extended range operations and any dispatch limitations;

ii) calculation of one-engine-inoperative fuel requirements under paragraph 3.4.5 (Fuel and Oil Supply) of this document; and

iii) establishing the level off altitude (net performance) data. This level off altitude (net performance) must clear any obstacles en route by margins as specified in applicable operating rules.

System

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

1. Airframe System - any system on the aeroplane that is not a propulsion system.

2. Propulsion System - the aeroplane power plant installation including each component that: is necessary for propulsion, affects the control of the major propulsion units or affects the safety of the major propulsion units (Airworthiness Manual 525.901(a)).

Unacceptable Thrust-Loss

Total thrust-loss or loss of thrust to an extent that would preclude continued controlled flight with the affected engine to an adequate airport, should the other engine fail.

Abbreviations

ACARS	Airborne Communication And Reporting System
AFM	Aircraft Flight Manual
APU	Auxiliary Power Unit
ATC	Air Traffic Control
BECMG	Becoming (Weather)
CDL	Configuration Deviation List
CMP	Configuration, Maintenance and Procedures Manual
CP	Critical Point

EEP	Extended Range Entry~~/Exit~~ Point
ER	Extended Range
ETP	Equal Time Point
EXP	Extended Range Exit Point
HAT	Height Above Threshold
HAA	Height Above Airport
IFSD	In Flight Shut Down
IPC	Illustrated Parts Catalogue
MCTOW	Maximum Certified Take-off Weight
MEL	Minimum Equipment List
MMEL	Master Minimum Equipment List
PMI	Principal Maintenance Inspector
POI	Principal Operations Inspector
PROB	Probability (Weather)
RAT	Ram Air Turbine
STC	Supplemental Type Certificate
TC	Type Certificate
TEMPO	Temporary (Weather)
PSRA	Propulsion System Reliability Assessment

Chapter 1
Policy and General Information

1.1 General

1.1.1 This document provides the policy, procedures and guidelines for obtaining Type Design and/or Operational Approval for two-engine transport category aeroplanes to operate over a specified route containing a point farther than 60 minutes flying time at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from an adequate airport regardless of terrain. The 60-minute threshold is a point beyond which the provisions of this publication will apply. Previously issued approvals for ETOPS/ EROPS programs will continue to be valid; requests for new ETOPS authorizations or changes to existing programs will be assessed under the criteria outlined in this document. Specific criteria are included for deviation of 75, 90, 120, or 138 minutes and beyond.

1.2 Applicability

1.2.1 This manual applies to all twin-engine aeroplanes with a MCTOW of more than 8618 kilograms (19,000 pounds) for which a Canadian type certificate has been issued authorizing the transport of 20 or more passengers (whether or not the individual aircraft is configured for 20 or more passengers) operated by a Canadian air operator in an air transport service. ETOPS does not apply to flights conducted wholly within Canadian Domestic Airspace.

1.3 Reference Regulations

1.3.1 This document is enabled by Section 705.26 of the *Canadian Aviation Regulation* (CAR 705.26).

1.4 Approval Procedures

1.4.1 Air operators requesting approval for Extended Range (ER) operations with two-engine aeroplanes shall submit their requests, with the required supporting documentation to the Director General, Civil Aviation at least 90 days prior to the proposed start of extended range operations.

1.4.2 The Aeroplane type design shall meet the requirements for ETOPS design features and criteria specified in Chapter 2 of this document; (Design Features Criteria).

Notwithstanding, ETOPS type design approval is not required for air operators requesting approval to conduct 75 minute operations in Benign Areas of Operations. The airframe-engine combination and the general scope of the operation will be reviewed by the POI and the PMI to determine if there are any factors that could affect the safe conduct of operations before an Operations Specification (Ops Spec) is issued.

1.4.3 In addition, for ETOPS operations other than 75 minutes Benign Area of Operation, the following criteria shall be met prior to conducting extended range operations:

a) the applicant shall satisfy the operational approval considerations specified in Chapter 3 of this document, (Operational Approval Criteria);

b) the applicant has a system to maintain and dispatch an ETOPS aircraft in accordance with an approved maintenance, reliability and training program that includes ETOPS requirements specified in Chapter 4 of this document, (ETOPS Maintenance and Reliability Requirements);

c) the applicant shall demonstrate that the maintenance checks, servicing, and programs called for in Chapter 4 of this document will be properly conducted;

d) the applicant shall also demonstrate that ETOPS flight release practices, policies, and procedures are established; and,

e) an operational validation flight, in the aeroplane or an approved simulator (as determined by Transport Canada, Civil Aviation (TCCA)on a case by case basis), shall incorporate demonstration of the following emergency conditions:

i) total loss of thrust of one engine;

ii) total loss of normal generated electrical power;

iii) total loss of pressurization;

iv) any other event or condition considered to be equivalent in operational challenge, safety management, crew workload or performance risk.

1.4.4 When the foregoing has been reviewed and found acceptable, a recommendation from the Principal Maintenance Inspector (PMI) shall be forwarded to the Chief, Airline Inspection (AARXD), or the Regional Manager, Commercial & Business Aviation (RMCBA) as applicable, for approval and the applicant shall be issued an Operations Specification to conduct ETOPS operations within specified limitations.

1.5 Continuity of ETOPS

1.5.1 Due to the special nature of ETOPS an air operator is required to maintain processes and procedures once ETOPS approval is issued.

1.5.2 Where an air operator ceases ETOPS operations for a period exceeding 13 months, application for re-instatement must be submitted in accordance with section 1.4 of this document.

Chapter 2
Design Features Criteria

2.1 General

2.1.1 A determination shall be made that the design features for a new transport category type design aeroplane intended to be used in ETOPS are suitable for such operations. In the event that an existing aeroplane's operation is expanded to include ER operations, a re-evaluation of some design features may be necessary.

2.1.2 Modifications to some systems may be required to achieve the desired reliability. In both cases essential systems and propulsion systems for the particular airframe-engine combination will be shown to be designed to fail-safe criteria and to have achieved a level of reliability suitable for the intended operation of the aeroplane.

2.2 Type Design Approval

2.2.1 Upon satisfactory completion of an engineering type design review and test program, which may include a Certification Flight Test evaluation, an ETOPS type design approval will be issued. The Aircraft Flight Manual (AFM) or Supplement and Type Certificate (TC) or Supplemental Type Certificate (STC) shall reference the CMP standard requirements for extended range operations and shall contain the following pertinent information, as applicable:

a) General limitations;

b) Required aeroplane limitations;

c) Revision to the performance section including fuel consumption rates;

d) Flight crew procedures;

e) Markings or placards

f) A statement to the effect that "the aeroplane has been found to meet the type design reliability and performance criteria for ETOPS operations in accordance with this document. Compliance with these type design criteria alone does not constitute approval to conduct ETOPS operations"; and

g) the Aircraft Type Certificate (TC) or STC should also document the design criteria used to establish compliance, including the effective date of the material.

2.3 Criteria

2.3.1 The evaluation of failures and failure combinations shall be based on engineering judgment and acceptable fail-safe methodology. The analysis should consider effects of operations with one engine inoperative, including allowance for damage that could result from failure of the first engine. 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.

2.3.2 **Airframe Systems (General)**

a) Airframe systems shall be shown to comply with section 525.1309 of the Airworthiness Manual, Chapter 525 (TP-6197).

b) Extended duration of single engine operations shall not require exceptional piloting skills and/or crew coordination. Considering the resulting 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 shall be minimized. Consideration shall also be given to the effects of continued flight with an engine and/or airframe systems inoperative on the flight crew's and/or passengers' physiological needs.

2.3.3 **Propulsion Systems**

a) The propulsion system shall be shown to comply with section 525.901 of the Airworthiness Manual, Chapter 525 (TP-6197).

b) In order to maintain a level of safety, consistent with other aircraft systems, it is necessary to have an acceptably low risk of double propulsion system failure for all design and operational related causes. This implies a relationship between propulsion system reliability and maximum approved diversion time.

c) It shall be shown that the propulsion system reliability has reached an acceptable level for ETOPS as determined in accordance with Appendix A of this document.

2.3.4 **Auxiliary Power Unit**

If an APU is required to satisfy the type design criteria for ETOPS, the installation shall meet:

1. the applicable Airworthiness Manual Chapter 525 requirements (TP-6197) (Subpart E - Powerplant);

2. any additional requirements necessary to demonstrate its ability to perform the intended function, i.e. start reliability, altitude, bleed air capability etc.

2.3.5 Communication, Navigation and Basic Flight Instruments

It shall be shown that, under all combinations of propulsion and/or airframe system failures which are not extremely improbable, reliable communication, sufficiently accurate navigation, and basic flight instruments needed to comply with contingency procedures for ETOPS will be available.

2.3.6 Cabin Pressurization

a) A review of fail-safe redundancy features shall show that the loss of cabin pressure is improbable under single engine conditions.

b) Aeroplane performance data shall be provided to verify the ability for continued safe flight and landing after loss of cabin pressure and subsequent operation at a lower altitude.

c) Unless it can be shown that cabin pressure can be maintained during single engine operation at the altitude required for continued flight to a suitable airport, oxygen shall be available to sustain the passengers and crew for the maximum diversion time.

2.3.7 Cabin Heating/Cooling

The air conditioning system must be capable of providing a reasonable cabin temperature in the event of any single or combination of failures not shown to be extremely improbable.

2.3.8 Equipment Cooling

The data shall establish that the required electronic equipment for ETOPS has the ability to operate acceptably with an engine shut down. Additionally, adequate indication of the proper functioning of the cooling system shall be verifiable if required, to assure system operation prior to dispatch.

2.3.9 Cargo Compartment

The cargo compartment design and fire protection system capability (if required) shall be consistent with the following:

1. Design - The cargo compartment fire protection system integrity and reliability shall be suitable for the intended operations considering fire detection sensors, liner materials, etc.;

2. Fire Protection - An analysis or test shall be conducted to show, considering approved maximum diversion time (under standard conditions in still air), (including an allowance for 15 minutes holding and/or an approach and landing), that the ability of the system to suppress or extinguish fires is adequate to ensure safe flight and landing at a suitable airport.

3. Main deck Class B cargo compartments (as defined in the Airworthiness Manual, Chapter 525, Section 525.857), with volumes in excess of 200 cubic feet, are to be modified to a Class C configuration or equivalent; and,

4. Class D cargo compartments, with volumes in excess of 200 cubic feet, are precluded from use in ETOPS.

2.3.10 **Ice protection**

Airframe and engine ice protection systems shall be shown to provide adequate protection capability (aircraft controllability, etc.) for the intended operation. This shall account for prolonged exposure to lower altitudes associated with one-engine-inoperative diversion, cruise, holding, approach, missed approach and landing.

2.3.11 **Electrical Power**

a) Three or more reliable and independent electrical power sources shall be available, each capable of powering essential systems independently. If one or more of the required electrical power sources are powered by an APU, hydraulic system, or ram air turbine, the following criteria apply as appropriate:

1. The APU, when installed, shall meet the criteria in Para 2.3.4 of this document.

2. The hydraulic power source must 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).

3. Ram air turbine deployment shall be demonstrated to be sufficiently reliable and not require main electrical or engine dependent power for deployment.

b) In the event of any single failure or combination of failures not shown to be extremely improbable, it shall be shown that electrical power is provided for:

1. Essential flight instruments, avionics, communications, navigation, supportive systems and any other equipment deemed necessary for extended range operations for continued safe flight and landing;

2. Crew cockpit information of sufficient accuracy for the intended operation; and

3. Instruments and equipment needed to allow the flight crew to cope effectively with adverse conditions.

2.3.12 **Hydraulic Power and Flight Controls**

a) Consideration of these systems may be combined, since many commercial aeroplanes have full hydraulically powered or "fly-by-wire" controls. For aeroplanes with these types of flight controls, evaluation of system redundancy shall show that single failures or failure combinations not shown to be extremely improbable do not preclude continued safe flight and landing.

b) As part of this evaluation, the loss of any two 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 (engine rotor burst need not be considered in this regard) .

2.4 Enroute Flight Paths

2.4.1 For aeroplanes for which ETOPS approval is required, the flight path, range performance and fuel flow shall be determined at each weight, altitude and temperature within the operating limits established for the aeroplane. The flight path and range performance shall be determined for each selected configuration with:

a) The most unfavorable center of gravity;

b) The critical engine inoperative;

c) The remaining engine at the available maximum continuous power or thrust;

d) The means for controlling the engine supplied air-conditioned air to ensure a reasonable cabin temperature; and

e) Consideration of the effects of icing on single engine performance.

Chapter 3
Operational Approval Criteria

3.1 General

3.1.1 In considering an application from an air operator to conduct ETOPS operations, an assessment shall be made of the air operator's overall safety record, past performance, flight crew training, maintenance training and maintenance reliability programs. The data provided with the request shall substantiate the air operator's ability to safely conduct and support these operations and shall include the means used to satisfy the criteria outlined in this section and in Chapter 4 (ETOPS Maintenance and Reliability Requirements).

3.2 Operational Approval Considerations

3.2.1 **Benign Area of Operation**

a) Consideration will be given to air operators requesting approval to conduct extended range operations within a Benign Area of Operation with minimal or no in-service experience with the airframe/engine combination. Although an ETOPS type design approval is not necessarily required, the airframe-engine combination will be reviewed to determine if there are any factors that would effect the safe conduct of operations. Furthermore, flights shall be operated at a weight that permits the flight, at the approved one-engine-inoperative cruise speed and power setting, to maintain flight altitude at or above the Minimum Enroute Altitude.

b) These approvals shall be limited to a maximum diversion time of 75 minutes.

3.2.2 **Demanding area of operations**

Each air operator requesting approval to conduct Extended Range Operations within a Demanding Area of Operation shall have, prior to commencement of Extended Range Operations, an ETOPS approved airframe-engine combination and approved Operation and Maintenance system which follow the standards prescribed in this document. Furthermore, each air operator shall satisfy the following minimum requirements:

1. <u>75 minute approval</u>

   i) Minimal or no in-service experience required;
   ii) Approved CMP

2. 90 minute approval

i) 6 months of operating experience;
ii) Approved CMP

3. 120 minute approval

i) 12 months of operating experience;
ii) Approved CMP

4. 138 minute approval

i) 3 months of 120 minute ETOPS operating experience ;
ii) ETOPS type design approval configuration may be to the 120 minute criteria, but any specific limitations may not be exceeded.

5. Greater than 138 minute approval

i) 12 months of 120 minute ETOPS, or above, operating experience;
ii) ETOPS type design approval for the intended operation (e.g. 180 minute CMP if only 120 and 180 configurations are specified). Specific limitations to reflect operational approval (e.g. propulsion system reliability, cargo fire protection) not to be exceeded.

3.2.3 The initial in-service experience may be reduced in accordance with an Accelerated ETOPS Operational Approval (see Appendix C of this document) in situations where an air operator can successfully demonstrate its ability and competence to achieve the necessary reliability required for ETOPS operations.

3.2.4 TCCA may require an increase in prerequisite in-service experience in cases where an abnormally low number of flights and/or ER segments have occurred.

3.3 Accelerated ETOPS Approval

3.3.1 The accelerated ETOPS Approval concept is based on a structured program of compensating factors and a step-by-step approach as outlined in Appendix C of this document. This is the same philosophy as the technical transfer analysis used to accelerate the aircraft ETOPS Type Design Approval. The content of the appendix is applicable only in consideration of granting an Operational Approval for an air operator intending to operate an airframe/engine combination which has been awarded Type Design Approval including ETOPS.

3.4 Flight Preparation and In-Flight Considerations

3.4.1 General

The flight dispatch criteria specified herein are in addition to, or to amplify, the requirements contained in applicable operational rules and specifically apply to extended range operations. Although many of the criteria in this document are currently incorporated into approved programs for other aeroplanes or route structures, the nature of ETOPS necessitates that compliance with these criteria be re-examined in view of the operations to ensure that the approved programs are adequate for this purpose.

3.4.2 Minimum equipment list (MEL)

a) System redundancy levels appropriate to the intended Extended Range Operations are to be reflected in the Master Minimum Equipment List (MMEL) and/or TC Supplement. An air operator's MEL may be more restrictive than the MMEL considering the kind of Extended Range Operation being considered, and equipment and service problems unique to the air operator. For aeroplanes already in operational service, the existing MEL shall be re-evaluated and adjusted to reflect system redundancy level requirements for ETOPS.

b) The ETOPS MEL criteria need not be applied for ETOPS operational approval in Benign Area of Operation (75 min.).

c) For other ETOPS operations, the air operator’s MEL shall be based on the information contained within the aircraft MMEL, the CMP document, and/or the TC Supplement as applicable.

3.4.3 System failure action during flight

a) The air operator shall develop a list of items that are considered ETOPS sensitive. This list shall be published in an appropriate document readily accessible to the flight crew. This list shall contain applicable CMP standards, limitations and procedures in addition to information stating requirements prior to entering the ETOPS segment of the flight. Furthermore, this list should contain direction to the flight crew for their action if any of the specified items fail during any phase of flight.

b) This document shall give specific direction for action required for both ETOPS and non-ETOPS phases of flight, and shall include, but is not limited to:

1. Electrics;
2. hydraulics;
3. pneumatics;
4. auto pilot;
5. fuel;

6. ice protection;
7. navigation and communications;
8. auxiliary power unit;
9. air conditioning and pressurization;
10. fire protection; and
11. enroute alternate weather limits.

c) The identified items and relevant procedures shall be acceptable to Transport Canada. A statement will be included to ensure that the Pilot in Command has the final authority in all phases of flight.

3.4.4 **Communication and navigation facilities**

An aeroplane shall not be dispatched on an ETOPS flight unless:

1. Communication facilities are available to provide, under normal conditions of propagation at the normal one-engine inoperative cruise altitudes, reliable two-way communications between the aeroplane and the appropriate ground communication facility over the planned route of flight and the routes to any suitable alternate to be used in the event of diversion. It shall be shown that current weather information, adequate status monitoring information and crew procedures for all aircraft and ground facilities' critical systems are available to enable the flight crew to make go/no go and diversion decisions;

2. non-visual ground aids are available and located so as to provide, taking account of the navigation equipment installed in the aeroplane, the navigation accuracy required over the planned route and altitude of flight, and the routes to any alternate and altitudes to be used in the event of an engine shutdown; and

    1. visual and non-visual aids are available at the specified alternates as required for the authorized types of approaches and operating minima.

3.4.5 **Fuel and Oil Supply**

a) **General**

1. Unlike the area of operation which is determined under standard conditions in still air, the fuel planning must consider the expected meteorological conditions along the planned route. Prior to dispatching an aircraft on an ETOPS flight, the air operator shall determine, for the planned route, both a standard and ETOPS fuel requirement. The fuel quantity required for dispatch is the greater of the two resulting fuel requirements.

2. An aeroplane shall not be dispatched on an ETOPS flight unless it carries sufficient fuel and oil to meet regulatory requirements of CAR 602.88 and CAR 705.25, including additional contingency fuel reserves that may be determined in accordance with 3.4.5 b) (Critical fuel reserves). In computing fuel and oil requirements, at least the following shall be considered:

   i) Current forecast winds and meteorological conditions along the expected flight path at one engine inoperative cruising altitude and throughout the approach and landing;

   ii) any requirement for operation of ice protection systems and performance loss due to ice accretion on the unprotected surfaces of the aeroplane;

      Note: Icing encounters shall be conservatively factored to account for the likelihood of an encounter, threat severity, encounter duration and anticipated flight crew action.

   iii) any required operation of auxiliary power unit (APU);

   iv) loss of aeroplane pressurization and air conditioning; consideration shall be given to flying at an altitude meeting oxygen requirements in the event of loss of pressurization;

   v) an approach followed by a missed approach and a subsequent approach and landing;

   vi) navigational accuracy required; and

   vii) any known Air Traffic Control (ATC) constraints.

      Note: APU oil consumption and servicing shall be considered in accordance with CMP document requirements.

b) **Critical fuel reserves**

In establishing the critical fuel reserves, the air operator is to determine the fuel necessary to fly from the most critical point to a suitable alternate under the conditions outlined in 3.4.5 c), (Critical fuel scenario). These critical fuel reserves should be compared to the fuel that will be on board at the most critical point based on a departure with the normal fuel required by regulations for the proposed trip. If it is determined by this comparison that the fuel that would be on board at the most critical point is less than the critical fuel reserves, then additional fuel shall be loaded to ensure that the fuel on board at the most critical point is equal to or greater than the critical fuel reserves.

In consideration of the items listed in 3.4.5 a), the critical fuel scenario shall allow for:

1. a contingency figure of 5 percent added to the calculated fuel burn from the critical point to a suitable alternate, to allow for errors in wind forecasts and fuel mileage;

2. any Configuration Deviation List and/or Minimum Equipment List items;

3. both airframe and engine anti-icing;

4. ice accretion on unprotected surfaces if icing conditions are likely to be encountered during the diversion; and

5. any required operation of an auxiliary power unit and/or Ram Air Turbine (RAT).

c) **Critical fuel scenario**

1. Calculation of the critical fuel reserve requires the air operator to determine the failure scenario that is the most operationally critical, considering time and aircraft configuration. Any failure or combination of failures not shown to be extremely improbable must be considered. The critical fuel reserve is the fuel required, taking into account the items listed in paragraph 3.4.5 b:

   i) to proceed from the most critical point to a suitable alternate following the occurrence of the most operationally critical event (s); plus,

   ii) upon reaching the suitable alternate, to descend to 1,500 feet above the airport, hold for 15 minutes, initiate an approach followed by a missed approach and then execute an approach and landing.

3. For example, if the critical scenario was determined to be the simultaneous failure of one propulsion system and the pressurization system, then the critical fuel reserves would be the fuel required to:

   i) At the most critical point, immediate descent to and continued cruise at 10,000 feet at the approved one-engine-inoperative cruise speed (fuel consumption may be based on continued cruise above 10,000 feet if the aircraft has sufficient supplemental oxygen in accordance with applicable regulations); and,

   ii) upon reaching the suitable alternate, to descend to 1,500 feet above destination, hold for 15 minutes, initiate an approach followed by a missed approach and then execute an approach and landing.

3.4.6 **Alternate Airports**

a) An aeroplane shall not be released on an extended range operation unless the required take-off, destination and alternate airports, including en route alternate airports to be used in the event of a system failure which requires a diversion, are listed in the operational flight plan, (e.g. on board copy of computer flight plan).

b) Suitable en route alternates are also required to be identified, listed and provided to the crew with the most up to date information (e.g. airport data, facilities, weather, etc.) as part of the dispatch release for all cases where the planned route of flight contains a point more than 60 minutes flying time at the approved one-engine-inoperative cruise speed from an adequate airport. Since these en route alternates serve a different purpose than the destination airport and would normally be used only in the event of an engine failure or the loss of a primary airframe system, an airport may not be listed as an en route alternate unless:

1. the landing distances required as specified in the Aircraft Flight Manual for the altitude of the airport, 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 airport authorities and computed in accordance with the applicable regulations;

2. the airport services and facilities are available and adequate for the air operator's approved approach procedure(s) and operating minima for the runway expected to be used;

3. the latest available forecast weather conditions for a period commencing one hour before the established earliest time of landing and ending one hour after the established latest time of landing at that airport, (Figure 1.) are equal to or exceed the authorized weather minima for en route alternate airports in appendix B;

4. for the same period, the forecast cross wind component for the intended landing runway, including gusts, is less than the maximum permitted cross wind for a single engine landing. Where no single engine demonstrated cross wind value exists, 80% of the all engine demonstrated value will be used; and,

5. during the course of the flight, the flight crews remain informed of any significant changes at en route alternates. Prior to proceeding beyond the ER Entry Point, the forecast weather for the time periods established in subparagraph 3.4.6 b) 3., aeroplane status, fuel remaining, runway surface conditions, landing distances, airport services and facilities shall be evaluated. If any conditions are identified which would preclude safe approach and landing, then the pilot shall be notified and an acceptable alternate(s) selected where safe approach and landing can be made.

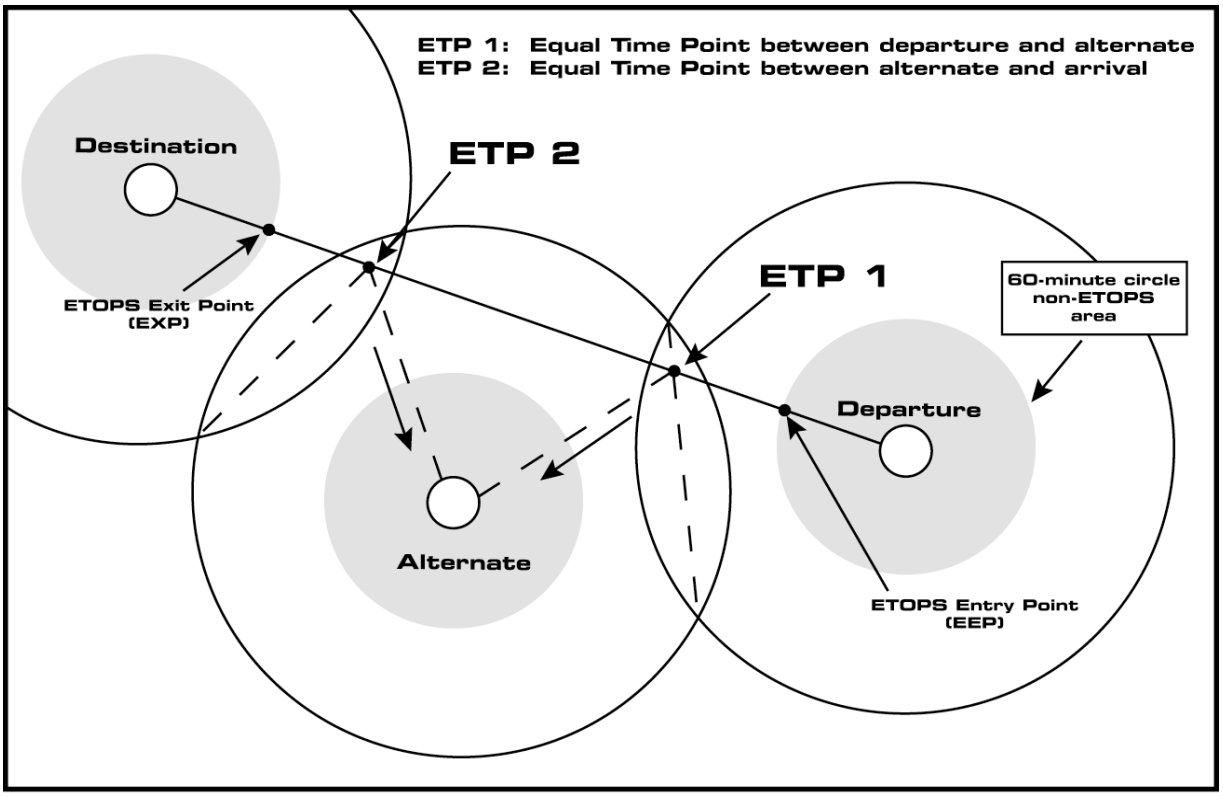


Figure 1.

c) Once the flight has entered the extended range segment, if the forecast for the en route alternate is revised to below the landing limits, the flight may continue at the Captain's discretion.

d) In addition, the air operator's program should provide flight crews with information on adequate airports appropriate to the route to be flown which are not forecast to meet Appendix B en route alternate weather minima. Airport facility information and other appropriate planning data concerning these airports should be provided to flight crews for use when executing a diversion.

Note: The alternate airports should be chosen in order to make it possible for the aeroplane to reach the alternate, especially with regard to performance (flight over obstacles) and/or oxygen requirements. A list of en route alternates and the en route alternate weather limits will be published in the air operator's Operations Manual.

3.4.7 **Aeroplane Performance Data**

No aeroplane shall be released on an extended range flight unless the air operator's Operations Manual contains sufficient data to support the critical fuel reserve and area of operations calculation. The following data shall be based on information provided or referenced in the approved Aircraft Flight Manual (AFM):

1. detailed single engine performance data including fuel flow for standard and non-standard atmospheric conditions and as a function of airspeed and power setting, where appropriate, covering:

   i) drift down (includes net performance);

   ii) cruise altitude coverage including 10,000 feet;

   iii) holding;

   iv) altitude capability (includes net performance); and

   v) missed approach.

2. 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:

   i) cruise (altitude coverage including 10,000 feet); and

   ii) holding.

3. details of any other conditions relevant to extended range operations which can cause significant deterioration of performance, such as ice accretion on the unprotected surfaces of the aeroplanes, Ram Air Turbine, thrust reverser deployment, etc.; and

4. the altitudes, airspeeds, thrust settings, and fuel flow used in establishing the ER area of operations for each airframe/engine combination must be used in showing the corresponding terrain and obstruction clearances in accordance with applicable regulations.

3.5 Flight Crew Training and Evaluation Program

3.5.1 The air operator's training program in respect to extended range operations shall provide training for flight crew members followed by subsequent evaluations and proficiency checks as well as recurrent training in the following areas:

a) introduction to ETOPS regulations/ operational approvals;

b) routes and airports intended to be used in the ER area of operations;

c) performance:

1. flight planning, and plotting, including all contingencies;

2. flight performance progress monitoring; and

d) procedures:

1. diversion procedures and diversion "decision making". Special initial and recurrent training to prepare flight crews to evaluate probable propulsion and airframe failures should be conducted. The goal of this training should be to establish crew competency in dealing with the most probable operating contingencies;

2. use of appropriate navigation and communication systems including appropriate flight management devices;

3. flight crews should be provided with detailed initial and recurrent training that emphasizes abnormal and emergency procedures to be followed in the event of foreseeable failures for each area of operation, including:

i) procedures for single and multiple equipment failures in flight that would precipitate go/no-go and diversion decisions. If standby sources of electrical power significantly degrade cockpit instrumentation, then approved training that simulates approaches with the standby generator as the sole power source should be conducted during initial and recurrent training;

ii) operational restrictions associated with these failures including any applicable MEL considerations;

iii) procedures for in-flight restart of the propulsion systems, including APU, if required; and

iv) crew incapacitation.

4. use of emergency equipment including protective breathing and ditching equipment;

5. procedures to be followed in the event that there is a change in conditions at designated en route alternates that would preclude a safe approach and landing;

6. understanding and effective use of approved additional or modified equipment required for ETOPS;

7. fuel requirements and management:

   Flight crews shall be trained on the fuel requirements and management procedures to be followed during the en route portion of the flight. These procedures should provide for an independent cross-check of fuel quantity indicators. (e.g. fuel flows could be used to calculate fuel burned and compared to indicated fuel remaining.

8. dispatch considerations (MEL, CDL, weather minima, and flight crew performed maintenance service checks); and

9. flight crew documentation.

3.5.2 Air operators shall standardize flight crew practices and procedures for ETOPS operations. Furthermore, only pilots with a demonstrated understanding of ETOPS operations shall be designated as training and/or check pilots for ETOPS operations.

3.6 Operational Limitations

3.6.1 **Areas of operation**

Following satisfactory compliance with these criteria, an air operator may be authorized to conduct ETOPS with a particular airframe-engine combination within a particular area of operation. The area of operation will be limited by the maximum approved diversion time to an adequate airport at the approved one-engine-inoperative cruise speed (under standard conditions in still air) from any point along the proposed route of flight. The area of operation approved shall be specified in an Operations Specification.

3.6.2 **Flight dispatch limitation**

Flight dispatch limitation shall specify the maximum diversion time from a suitable airport for which an air operator can conduct a particular ETOPS operation. The maximum diversion time at the approved one-engine-inoperative cruise speed shall not be any greater than the value specified in the Operations Specification.

3.6.3 **Use of standard maximum diversion time**

The procedures established by the air operator should ensure that extended range operation is limited to flight plan routes where the approved maximum diversion time to suitable airports can be met under standard conditions in still air. Air operators shall ensure that:

1. Company procedures require that upon occurrence of an in-flight shutdown of an engine, the pilot shall, subject to the *PIC's Authority*, promptly initiate a diversion and fly to and land at the nearest airport, in point of time determined to be acceptable by the flight crew; and,

2. a procedure shall be established such that in the event of a single or multiple critical system failure, the pilot shall, subject to the *PIC's Authority*, promptly initiate a diversion procedure and fly to and land at the nearest airport, in point of time determined to be acceptable by the flight crew, unless it can be established that no substantial degradation of safety results from continuation of the planned flight.

3.6.4 **Pilot-in-command authority**

Contingency procedures or plans should not be interpreted in any way which prejudice the final authority and responsibility of the Pilot-In-Command for safe operation of the aeroplane

3.7 Operations Manual

3.7.1 An air operator's Company Operations Manual or training manuals shall outline the training and standard operating procedures applicable to ETOPS operations in addition to, but not limited to, the following:

a) minimum altitudes to be flown along planned and diversionary routes as applicable;

b) airports authorized for use, including alternates and associated instrument approaches and operating minima; and

c) the information used in determining the critical fuel scenario.

3.8 Operations Specifications

3.8.1 An air operator's aeroplanes shall not be operated on ETOPS Operations unless the air operator has complied with all the provisions of this document and the flight is authorized by an Operations Specification.

3.8.2 An Operations Specification for ETOPS Operations shall specifically include provisions covering at least the following:

a) approved area of operation;

Note: Flights may be planned to operate through sectors outside of the delimiting arcs, provided the sector crossing is less than 30 track miles); and

b) for each ETOPS approved airframe-engine combination, the maximum diversion time, at the approved one-engine-inoperative cruise speed, that any point on the route may be from a suitable airport.

Chapter 4
ETOPS Maintenance and Reliability Requirements

4.1 General

4.1.1 Maintenance and personnel involved must be made aware of the special nature of ETOPS and have the knowledge, skills and ability to accomplish the requirements of the program. Therefore, the maintenance control system shall contain the standards, guidance and direction necessary to support the intended operation of ETOPS aircraft.

4.1.2 The Principal Maintenance Inspector (PMI) having jurisdiction over the air operator must assess the air operator's maintenance program as being suitable to support the proposed ETOPS operation before the operational approval for ETOPS can be granted.

4.2 Maintenance Program

4.2.1 The maintenance control system being considered for ETOPS approval, must be reviewed in conjunction with the aircraft maintenance schedule, to ensure that it provides an adequate basis for development and inclusion of specific ETOPS maintenance requirements as defined in the CMP document for the airframe/engine combination. These shall include procedures to ensure that aircraft are not dispatched for an ETOPS flight following maintenance actions that affect multiple similar elements in any ETOPS critical system (e.g. fuel control change on both engines).

a) ETOPS related tasks must be identified on the air operator's routine work forms and related instructions.

b) ETOPS related procedures, such as involvement of centralized maintenance control or technical dispatch, must be clearly defined in the air operator's maintenance program.

c) An ETOPS service check must be developed and used to verify that the status of the aeroplane and certain critical items are acceptable. This check will be accomplished by an ETOPS qualified person prior to every ETOPS flight. The air operator may authorize suitably trained persons to perform this check under the “elementary work” provision of CAR 571 and CAR 605, provided the check is not incorporated into the aircraft maintenance schedule, and does not include any item that requires a maintenance release.,

d) The air operator evaluation program must encompass the review of the aircraft technical record. This review is to ensure proper MEL procedures, deferred items,

maintenance checks have been performed properly and system verification procedures are effective.

4.3 ETOPS Manual

4.3.1 The air operator Maintenance Control Manual shall be amended to address ETOPS operations. The manual must include, either directly or by reference to incorporated documents, the requirements described in this Chapter.

4.3.2 All ETOPS requirements, including supportive program procedures, duties and responsibilities, must be identified as being ETOPS sensitive. The amended manual must be submitted to the PMI for approval with sufficient lead time prior to the scheduled commencement of ETOPS Operations of the particular aircraft (airframe-engine combination).

4.4 Oil Consumption

4.4.1 The air operator's oil consumption program should reflect the type certificate holder's recommendations and be sensitive to oil consumption trends. It should consider the amount of oil added at the departing ETOPS stations with reference to the running average consumption; i.e. the monitoring must be continuous up to, and including, oil added at the ETOPS departure station. If oil analysis is meaningful to this make and model, it should be included in the program. If the APU is required for ETOPS operation, it must be added to the oil consumption program.

4.5 Engine Condition Monitoring

4.5.1 This program will describe the parameters to be monitored, method of data collection and corrective action process. The program should reflect the type certificate holder'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 is affected. The program must ensure that engine limit margins are maintained so that a prolonged single-engine diversion may be conducted without exceeding approved engine limits (i.e. rotor speeds, exhaust gas temperatures) at all approved power levels and expected environmental conditions. Engine margins preserved through this program must also 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.

4.6 Verification Program

4.6.1 The air operator will develop a verification program that includes procedures to ensure appropriate corrective action following an engine shutdown, primary system failure or adverse trend(s) for any prescribed event(s) which require a verification flight, or other action, and establish means to assure their accomplishment. A clear description of who must initiate verification actions and the section or group responsible for the determination of what action is necessary must be identified in the program. Primary systems or conditions requiring verification actions must be described in the air operator's ETOPS manual.

4.7 Reliability Program

4.7.1 The air operator's existing reliability program must be supplemented as applicable to take account of ETOPS. The program should be designed with early identification and prevention of ETOPS related problems as the primary goal as well as ensuring that the minimum ETOPS reliability levels are maintained. The program should be event-oriented and incorporate reporting procedures for significant events detrimental to ETOPS flights. This information will be readily available for use by the air operator and the PMI to help establish that the reliability level is adequate, and to assess the air operator's competence and capability to safely continue ETOPS Operations. An ETOPS reporting program will be established by the air operator to ensure that the PMI is notified at least monthly, or more often if events reportable through this program are identified.

4.7.2 The air operator must also ensure that procedures are established and implemented that will roll back the approved ETOPS diversion time should the engine in flight shutdown rate exceed the limits specified in Appendix A of this document. The air operator's "person responsible for the maintenance control system" (PRM) must have the authority to initiate roll back of the approved ETOPS diversion time.

4.7.3 Where reliability data indicate that the "target criteria" per Appendix A of this document, Figure 1, are no longer being met, the air operator must notify their PMI of the corrective measures taken. Where the "minimum criteria" are no longer being met, the air operator must roll back the ETOPS diversion time to that specified in the Appendix for the particular IFSD rate noted. If required, the PMI will consult with AARDD/P for interpretation and/or guidance on a case by case basis.

4.7.4 Failure of an air operator to roll back the maximum diversion time when required will constitute grounds for removal of ETOPS authority.

4.7.5 The following items will be included in the reporting program:

a) in-flight shutdowns or flameouts;
b) diversion or turn-back;
c) uncommanded power changes or surges;

d) inability to control the engine or obtain desired power;
e) problems with systems critical to ETOPS (engine bleed air, pressurization, electrical power, etc.).

4.7.6 The report will also identify the following:

a) aircraft identification;
b) engine 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.

4.8 Contracted Maintenance and Reliability

4.8.1 Air operators who contract any part of their maintenance control and/or reliability programs, necessary to support their ETOPS approval, to any other organization, remain responsible for ensuring that all elements of this program are addressed and continue to meet the applicable requirements.

4.8.2 For those air operators whose ETOPS approval is based on reliability levels established by other organizations, Transport Canada will not consider ETOPS approval privileges beyond those issued to these organizations by their respective Civil Aviation Authority.

4.9 Propulsion System Monitoring

4.9.1 The air operator's assessment of propulsion systems reliability for the ETOPS fleet should be made available to their PMI (with supporting data) in accordance with an agreed upon frequency, to ensure that the approved maintenance program continues to maintain a level of reliability necessary for Extended Range Operations.

4.9.2 The assessment will include, as a minimum, engine hours flown in the period, in flight shut-down rate for all causes and engine removal rate, both on a 12 month moving average basis. Where the combined ETOPS fleet is part of a larger fleet of the same aircraft/engine combination, data from the air operator's total fleet will be acceptable. However, the reporting requirements of paragraph 4.7 of this Chapter must still be observed for the ETOPS fleet.

4.9.3 Any adverse sustained trend shall require an immediate evaluation to be accomplished by the air operator in consultation with the PMI. The evaluation may result in corrective action or operational restrictions being applied.

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

4.10 Technical Training

4.10.1 Technical training will focus on the special nature of ETOPS. This training shall be included as an integral part of the air operator's maintenance program. The goal of this element of the program is to ensure that all personnel who are assigned ETOPS responsibilities (including dispatch, parts control or any other ETOPS related function) are provided with the necessary training so that ETOPS tasks are properly accomplished. Qualified personnel are those that have completed the air operator's ETOPS training program and have satisfactorily performed ETOPS tasks under supervision, within the framework of the air operator's approved procedures for Personnel Authorization.

4.11 ETOPS Parts Control

4.11.1 The air operator will develop a parts control program, that ensures that appropriate parts are installed on ETOPS aircraft. The program must include means to verify that parts installed on ETOPS aircraft, including parts obtained through borrowing or pooling arrangements, conform to the applicable ETOPS configuration for that aircraft.

Propulsion System Reliability Assessment

A.1 General

A.1.1 Type Design Approval

To establish if a particular airframe-engine combination has satisfied the propulsion system reliability criteria for ETOPS, a thorough assessment shall be conducted by specialists of the responsible airworthiness authority for airframe-propulsion system design utilizing all the pertinent engine and airframe-propulsion system data and information available (includes the APU, if required).

Transport Canada, certification office will review these findings as part of the aircraft type design approval activity.

A.1.2 Operational Approval

The intent of the operational approval is to establish if an air operator has demonstrated the capability of ensuring propulsion system reliability targets have been met and will continue to be met.

A.2 Concepts and Criteria

No single parameter by itself, without other data/information, can adequately qualify reliability. There are a number of variables, maintenance and operating statistics and general information about the operational experience of a particular power unit, which characterize propulsion system reliability. Engineering judgment must then be utilized to determine the adequacy and applicability of this data and information to ETOPS and to determine the suitability of the aeroplane for ETOPS. As an aid in making this judgment, statistical analysis will be used to help determine that the desired level of reliability is obtained.

The evidence must be such that it can be shown with high confidence that the risk of total thrust loss or loss to an extent that precludes continued safe flight, is acceptably low, i.e., at an appropriate level less than between 10^{-8} and 10^{-9} per hour during the relevant portion of the cruise.

A.3 Assessment

Appendix A

To assess adequately the propulsion system reliability for ETOPS type design and operational approval, certain world fleet data and information are required. The Regulatory specialists will maximize the use of existing sources and kinds of data generally available but additional data may be required in certain cases.

A.3.1 Data Requirements

A3.1.1 Type Design Approval - World fleet data and information are necessary to adequately assess propulsion system reliability for ETOPS. This data shall include:

1. A list of all engine shutdown events both ground and in-flight for all causes (excluding normal training events) including flameout. The list shall provide the following for each event: data, airline, aeroplane and engine identification (model and serial number), power unit configuration and modification history, engine position, symptoms leading up to the event, phase of flight or ground operation, weather/environmental conditions and reason for shutdown.

2. A list of all occurrences where achieved thrust was below the intended level, for whatever reason: The list shall provide the above detailed information.

3. Data concerning total engine hours and aeroplane cycles (if known, include engine hour distribution, e.g., percent of world fleet of engines at 1,000 hours, 2,000 hours, etc.).

4. Data listing mean time between failure of the propulsion system and associated components that affect reliability (unscheduled removals).

5. The amount and frequency of using reduced/de-rated thrust (if detailed data is not available, a representative sampling may be sufficient); and

6. Additional data as specified by the specialist group.

A.3.1.2 Operational Approval - Data requirements for ETOPS Type Design Approval A.3.1.1) limited to air operator fleet experience and any experience claimed as compensatory experience (see Engineering Assessment A.3.3).

A.3.2 Experience

A.3.2.1 Type Design - In support of applications for ETOPS type approval, data shall be provided from various sources to ensure completeness, i.e., engine manufacturer, air operator and aeroplane manufacturer.

To provide a reasonable indication of reliability trends and significant problem areas, an accumulation of at least 150,000 engine hours is normally required in the world fleet before the assessment process can produce meaningful results. This number of hours may be reduced if adequate compensating factors are established which give a reasonable equivalent data base.

Once an assessment has been completed and the specialist groups have documented their findings, the Director, Aircraft Certification, will declare whether or not the current propulsion system reliability of a particular airframe-engine combination satisfies the relevant criteria of this document. Transport Canada will specify items required to qualify the propulsion system suitable for ETOPS, such as the recommended propulsion system type design configuration, operating conditions, maintenance requirements and limitations.

A.3.2.2 Air operator - Operational experience is required to ensure the air operator can and will continue to maintain and operate the particular aircraft-engine combination at an acceptable level of reliability. The assessment of an air operator's suitability to be granted an ETOPS approval is routinely made after a minimum amount of operating experience. Operational experience requirements may be reduced if adequate compensatory experience factors exist (see Appendix C of this document). The accepted basic experience requirements is defined in Chapter 3 of this document.

A.3.3 Engineering Assessment

A.3.3.1 An analysis, on a case-by-case basis, of all significant failures, defects and malfunctions experienced in service (or during testing) for the airframe-engine combination shall be addressed. Significant failures are principally those causing or resulting in in-flight shutdown or flameout of an engine but may also include unusual ground failures and/or unscheduled removal of engines from the aeroplane. In making the assessment, consideration is given to the following:

a) the type of power unit, previous experience, whether the power unit is new or a derivative of an existing model and the engine operating rating limit to be used with one-engine shutdown;

b) the trends in cumulative and six and twelve months rolling average, updated quarterly, of in-flight shutdown rates versus propulsion system flight hours and cycles;

c) the effect of corrective modifications, maintenance, etc., on future reliability of the propulsion system;

d) maintenance actions recommended and performed and its effect on engine and APU failure rates;

e) the accumulation of operational experience which covers the range of environmental conditions likely to be encountered; and

f) intended maximum flight duration, maximum diversion and mean diversion time used in ETOPS.

A.3.3.2 Type Design - An assessment of the corrective actions planned or taken for each problem identified with the objective of verifying that the action is sufficient to correct the deficiency.

When each identified significant deficiency has a corresponding Transport Canada accepted corrective action and when all corrective actions are satisfactorily incorporated and verified, Transport Canada determines that an acceptable level of reliability can be achieved. Statistical corroboration will also be utilized.

Any certification inspections and tests that may be necessary to approve these corrective actions will be the responsibility of the appropriate Design Approval Authority. The required corrective action and modifications will be included in the type design standard necessary for final type approval of the aeroplane for ETOPS.

A.3.3.3 Operations - Transport Canada recognizes that a number of potential countable events (e.g. IFSDs, flameouts, uncommanded thrust reductions, etc.) are not ETOPS relevant or action has been taken to preclude further occurrences. An air operator may request, through the Transport Canada Center Maintenance office or PMI to Aircraft Certification Engineering - Powerplants, that such an event be discounted so that the propulsion system reliability objective is not affected. Any configuration, maintenance or procedural change to satisfy the event discounting must become part of the air operators ETOPS CMP criteria. (Credit for optional equipment, e.g. ACARS, must be reviewed against MEL criteria).

A.4 Propulsion System Reliability Objective

A.4.1 Type Design

A determination will be made that the type design of the propulsion system achieves the desired level of reliability. Transport Canada will determine if the probability of total/unacceptable thrust loss due to design related and/or independent causes meet the criteria of this section.

A.4.2 Operations

A.4.2.1 A determination will be made of the propulsion system's ability to achieve the desired level of operational reliability in ETOPS. Transport Canada will determine if the probability of total/unacceptable thrust loss for all independent causes meets the criteria of this section.

A.4.2.2 The propulsion system reliability objective will ensure that the propulsion system achieves at least the minimum reliability criteria required of other critical aircraft systems, i.e., navigation, flight control, communications, etc.

Considering the complexity of the entire powerplant system, the approach to determine the reliability has been to use in-service data. This data therefore, not only considers design related failures (Airworthiness Manual Section 525.1309 approach), but also includes maintenance and operational effects on the failure rates

The events to be considered are to include those occurring from the beginning of the take-off roll to the end of the landing phase, though items confirmed as not ETOPS significant will be discounted. Failures considered are, engine in-flight shutdowns (IFSD), any other significant power loss or loss of engine control. The reliability objective used by Transport Canada relates diversion time to the probability of a loss of thrust which precludes continued safe flight.

Appendix A

The target is expressed by the following formula:

$$(10^9)(Pe^2)(t)\leq 1$$

where

Pe = probability of an engine failure (per hour)

t = diversion time (hours)

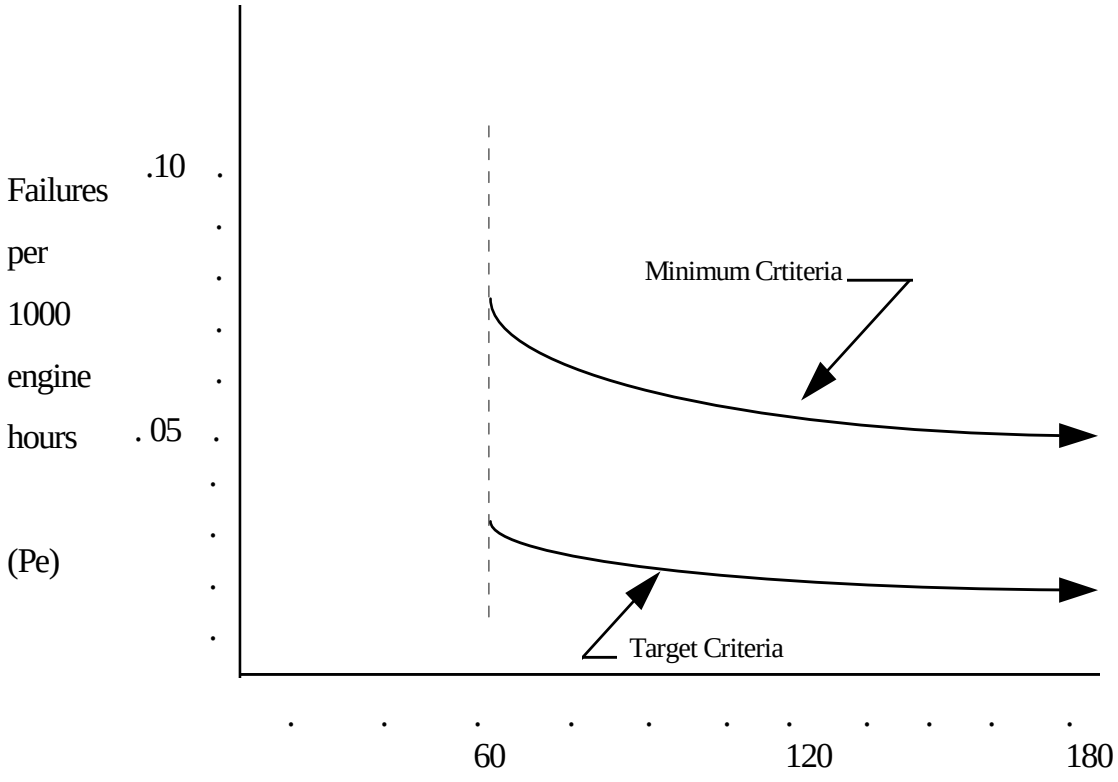
(10^9) represents the life of an entire aircraft fleet (hours)

Transport Canada believes some tolerance is required to account for verified corrective actions and precautionary shutdowns and also to provide for the expected variance over time in propulsion system reliability statistics. Reported occurrences beyond the tolerance will be grounds for withdrawal of ETOPS approval, or reduction in allowed diversion time. The maximum criteria is defined by the following formula:

$$(.25)(10^9)(Pe^2)(t)\leq 1$$

Figure 1

Propulsion System Reliability Objective



Appendix A

Diversion Time (minutes) (t)

Reliability Table (Engine Failures per 1000 hours)

Diversion Time (t)	Target Criteria	Minimum Criteria
60 minutes	.032	.063
75 minutes	.028	.056
90 minutes	.026	.052
120 minutes	.022	.044
138 minutes	.021	.042
180 minutes	.018	.036

Suitable Enroute Alternate Aerodromes

B.1 General

One of the distinguishing features of ETOPS is the concept of a suitable alternate airport being available to which an aircraft can divert after a single or combination of failures which require a diversion. Whereas most two-engine aeroplanes operate in an environment where there is usually a choice of diversion airports available, the extended range aeroplane may have only one alternate within a range dictated by the endurance of a particular airframe system (e.g. cargo fire suppressant), or by the approved maximum diversion time for that route.

It is, therefore, important that any airports designated as an en route alternate have the capabilities, services and facilities to safely support that particular aeroplane and that the weather conditions at the time of arrival provide a high assurance that adequate visual references are available upon arrival at decision height (DH) or minimum descent altitude (MDA) and that the surface conditions are within acceptable limits to permit the approach and landing to be safely completed with an engine and\or systems inoperative.

B.2 Adequate Airport

As with all other operations, an air operator desiring any route approval is required to show that it is able to satisfactorily conduct operations between each required airport over that route or route segment. Air operators are required to show that the facilities and services specified are available for their use and adequate for the proposed operation. For the purpose of this document, in addition to meeting these criteria, those airports which meet Transport Canada standards or ICAO Annex 14 and are determined to be useable by that particular aeroplane, will be accepted as adequate airports.

B.3 Suitable Airport

For an airport to be suitable for the purposes of this document, it shall have the capabilities, services and facilities necessary to be designated as an adequate airport and have weather conditions and field conditions at the time of the particular operation which provide a high assurance that an approach and landing can be safely completed with an engine and/or systems inoperative, in the event that a diversion to an en-route alternate becomes necessary. For planning purposes, the en route alternate weather minima are higher than the weather minima required to initiate an instrument approach.

Appendix B

B.4 Standard En Route Alternate Weather Minima

The following are established for flight planning and dispatch purposes in ETOPS operations:

A particular airport may be considered a suitable airport for flight planning and dispatch purposes for ETOPS operations if it meets the criteria of paragraph B.3 of this Appendix and has one of the following combinations of instrument approach capabilities and en route alternate airport weather minima at the time of the particular operation.

FACILITIES AVAILABLE AT SUITABLE ALTERNATE	CEILING	VISIBILITY
2 or more useable precision approaches each providing straight-in minima to separate suitable runways.(Two separate landing surfaces)	400 feet, or 200 feet above the lowest useable HAT, whichever is higher.	1 s.m., or 1/2 s.m. more than the lowest useable visibility limit, whichever is greater.
1 useable precision approach.	600 feet, or 300 feet above the lowest authorized HAT/HAA, whichever is higher.	2 s.m., or 1 s.m more than the lowest published landing visibility, whichever is greater.
1 useable non-precision approach.	800 feet, or 300 feet above the lowest authorized HAT/HAA, whichever is higher.	2 s.m., or 1 s.m more than the lowest published landing visibility, whichever is greater.

See A.I.P. Canada, GEN section for conversion factors/tables.

Note: Weather forecasts that contain the term BECMG, TEMPO or PROB may be used to determine the weather suitability of an aerodrome as an alternate provided that:

a) where the conditions are forecast to improve, the forecast BECMG condition shall be considered to be applicable as of the end of the BECMG time period, and these conditions shall not be below the published alternate minima requirements for that aerodrome; and,

b) where the conditions are forecast to deteriorate, the forecast BECMG condition shall be considered to be applicable as of the start of the BECMG time period, and these conditions shall not be below the published alternate minima requirements for that aerodrome; and,

c) the forecast TEMPO condition shall not be below the published alternate minima requirements for that aerodrome; and,

d) the forecast PROB condition shall not be below the appropriate landing minima for that aerodrome. Where a condition is forecast as "PROB", provided the probability per cent factor is less than 40 per cent, it is not limiting. However the Pilot-In-Command will exercise good aviation judgment in assessing the overall "PROB" conditions.

Accelerated ETOPS Operational Approval

C.1 General

This appendix is a means to identify factors which Transport Canada may consider to allow a reduction or substitution of the air operator in-service experience requirements prior to granting Accelerated ETOPS Operational Approval.

An excellent propulsion related service safety record for two-engine aeroplanes has been maintained since the introduction of ETOPS. Current data indicates that the ETOPS process benefits are achievable without extensive in-service experience. Therefore, reduction or elimination of in-service experience requirements may be possible when the air operator demonstrates that adequate and validated ETOPS processes are in place.

The Accelerated ETOPS Operational Approval Program with reduced in-service experience does not imply that a reduction of existing levels of safety will be tolerated but rather acknowledges that an air operator may satisfy the objectives of this document by an equivalent means when considering demonstrated operational capability.

This appendix permits an air operator to start ETOPS when they have established that those processes necessary for successful ETOPS operations are in place and are considered to be reliable. It should be emphasized that failure to meet the established criteria, milestones or reliability levels may result in the losing of the Accelerated ETOPS Operational Approval.

C.2 Policy

C.2.1 ETOPS Process

The airframe-engine combination for which the air operator is seeking Accelerated ETOPS Operational Approval must be ETOPS Type Design approved. The air operator must demonstrate that they have a program in place to address the process elements identified in this section.

The following are the ETOPS process elements:

a) Airframe/engine compliance to Type Design Build Standard (CMP)

b) Compliance with the Maintenance Requirements (Chapter 4 of this document), requiring the following proven ETOPS programs to be in place:

    1. Fully developed Maintenance Program, including tracking and control;

2. Oil consumption monitoring;

3. Engine condition monitoring;

4. Reliability;

5. Propulsion system monitoring; air operator to establish a program that results in a high degree of confidence that the propulsion system reliability appropriate to the ETOPS diversion time will be maintained;

6. Training and qualification for maintenance personnel;

7. ETOPS parts control;

8. Aircraft discrepancy resolution.

c) Compliance with the Flight Operations Program for ETOPS (Chapter 3 of this document) which must address:

1. Flight planning and dispatch programs;

2. Availability of meteorological information;

3. Minimum Equipment List considering ETOPS;

4. Initial and recurrent training and checking program for flight operations personnel;

5. Flight crew and dispatch personnel familiarity with routes, and requirements for, and selection of, en route alternates.

d) Documentation of the following elements:

1. Technology new to the air operator and significant differences in primary and secondary power/systems (engines, electrical, hydraulic and pneumatic) between the aeroplanes currently operated and the aeroplanes for which the air operator is seeking Accelerated ETOPS Operational Approval.

2. The plan to train flight and maintenance personnel to the differences identified in paragraph d)1. above.

3. The plan to use proven or manufacturer validated Training, Maintenance & Operations Manual procedures relevant to ETOPS for the aeroplane.

4. Changes to any previously proven or manufacturer validated Training, Maintenance or Operations Manual procedures described above. Depending on the nature of the changes, the air operator may be required to provide a plan for validating such changes.

5. Details of any ETOPS program support from the airframe manufacturer, engine manufacturer, other air operators or any other outside agency.

6. The control procedures when maintenance or flight dispatch support is provided by an outside party as described above.

C.2.2 Application

Air operators shall submit an "Accelerated ETOPS Operational Approval Plan" to Transport Canada 6 months before the proposed start of operations. This period will give an opportunity for the air operator to incorporate any refinements that may be required to achieve an Accelerated ETOPS Operational Approval.

The air operator's application for Accelerated ETOPS Operational Approval should:

a) define proposed routes and necessary diversion times;

b) define processes and resources allocated to initiate and sustain ETOPS;

c) identify plan for establishing and maintaining ETOPS build standard compliance;

d) document plan for compliance with items outlined in Paragraph C.2.1;

e) define Review Gates (a Review Gate is a milestone tracking plan to allow to define the tasks and timing for the necessary tasks to be accomplished); items for which TCCA visibility or approval is sought should be included in the Review Gates.

C.2.3 Operational Approvals

Air operators will be considered on individual merit and capability (case-by-case basis). Accelerated ETOPS Operational Approval is not guaranteed and air operators should await approval prior to planning revenue extended range operations.

Accelerated ETOPS Operational Approvals which are granted with reduced in-service experience should be limited to those areas agreed by TCCA contained within the Accelerated ETOPS Operational Approval Plan. Concurrence from TCCA is required should the air operator wish to add or expand the request..

Air operators may be eligible for Accelerated ETOPS Operational Approval up to the Type Design Approval limit.

C.2.4 Process Validation

The air operator should demonstrate that the process, discussed in paragraph C.2.1, is in place and functions as intended. This may be accomplished by thorough documentation and analysis, or by demonstration on an aircraft (simulation).

If an air operator is currently operating ETOPS on different equipment only minimal documentation may be necessary.

The following elements are beneficial in justifying a reduction in the validation requirements of the ETOPS process:

a) Experience with other similar airframes and or engines.

b) Previous ETOPS experience.

c) Long range, over-water operational experience.

d) Flight crew, maintenance and flight dispatch personnel experience with ETOPS.

A process may be validated initially by demonstration on a different aeroplane type. It is then necessary to demonstrate that means are in place to assure equivalent results occur on the aeroplane being proposed for Accelerated ETOPS Operational Approval.

Any validation program should address the following:

a) Assurance that the validation program will not be allowed to adversely impact actual safety of operations especially during periods of abnormal, emergency, or high cockpit workload operations. It should emphasize that during these abnormal situations that the validation exercise may be terminated.

b) A means to monitor and report performance with respect to accomplishment of tasks associated with ETOPS process elements. Any changes to ETOPS maintenance and operational process elements should be defined.

C.2.5 Accelerated ETOPS Surveillance

Air operators must be aware that any deficiencies associated with engineering and maintenance programs, flight dispatch or flight crew performance may result in the rejection of, amendment to, the claimed credit for reduced in-service experience.

Therefore, an accelerated program leading to an ETOPS Operational Approval is considered feasible so long as the air operators retain commitment to the standards which are contained in their ETOPS Operational Approval Plan and associated programs. During the first year of operation close monitoring will be exercised.

C.2.6 Minimum Requirements

1. As detailed in Chapter 3 of this document, the basic operational experience requirement for a given aircraft/engine combination is:

    a) 12 months operation for 120 minute approval;
    b) 3 months of 120 minute ETOPS experience for 138 minute approval; and
    c) 12 months of 120 minute or greater ETOPS experience for greater than 138minutes.

2. The Accelerated ETOPS Operational Approval allows for a reduction of in-service experience, based on the degree of compliance with the existing air operator's ETOPS program, which can be validated with supporting documentation. The typical operational experience requirements for a given aircraft-engine combination is:

    a) Nil experience for 75 minutes (ETOPS and CMP program in place);
    b) 3 months ETOPS experience for 90 minute approval; and
    c) 6 months ETOPS experience for 120 minute approval.

3. All in-service experience requirements noted above assume acceptable performance. Air operator ETOPS program difficulties may require additional in-service experience ... and/or removal of the eligibility for Accelerated ETOPS Operational Approval.