EDTO Workshop

Module N° 4 – Aircraft certification considerations
Course Structure

Module 1  
Course introduction

Module 2  
Basic concepts

Module 3  
Approval

Module 4  
Aircraft Certification Considerations

Module 5  
Maintenance Considerations

Module 6  
Flight Operations Considerations

Module 7  
Implementing EDTO Regulations

Module 8  
Continued Surveillance

Module 9  
Summary

Module 10  
Assessment
At the end of this module, participants will be familiar with the affected areas of airplane type design and reliability demonstrating the EDTO capability of the aircraft.
EDTO Design and Reliability Standards and Airplane Capability
- Assessment of EDTO Type certification basis and identify additional national requirement

Establish Certification Plan (including Early EDTO certification) and Achieve Approval

EDTO Specific Flight Test Test Requirements

Identification of the EDTO Configuration, Maintenance, and Procedures standards to be introduced in the EDTO CMP Document and in other relevant tools and documents

EDTO reliability monitoring of worldwide fleet by State of design
EDTO Type Design Assessment

- Airplanes with more than 2 engines (EDTO certification is NOT required)
- Airplanes with 2 engines (EDTO certification is required)

EDTO Type Design standards

EDTO certification process (twin engine aircraft)
- Type Design and Reliability assessment
- IFSD Rate
- Continued monitoring of in-service reliability
- Early EDTO certification

EDTO aircraft documentation
- CMP document / AFM / …

Conclusions
To operate beyond threshold, two conditions must be met:

**Aircraft Certification**

*Applicant:* MANUFACTURER

- ICAO Annex 8
- EASA AMC 20-6
- FAA FAR 25

**Prime Certification Authority** + **Validation Authorities**

**Operational Approval**

*Applicant:* OPERATOR

- ICAO Annex 6
- EASA CAT-OP
- FAA FAR 121

- NAA Rules
- EASA AMC 20-6
- FAA FAR AC 120-42B

**National Aviation Authority**

Must be obtained before approval of Operator for EDTO
As per ICAO standards, the aircraft manufacturer must perform an assessment of the aircraft design to identify / confirm the capability of relevant Time Limited System(s):

- The capability of Time Limited System must be considered at dispatch for the purpose of identification and selection of en-route alternates (verification of weather).

- Usually, it is the capability of the Cargo Fire Suppression system which defines the applicable limitation for EDTO.

There are no additional maintenance requirements nor additional certification requirements.

- Note: a given State may require an EDTO certification provided related design and reliability criteria have been defined.

The EDTO certification requirements detailed in the following slides are therefore applicable to Twin engine aircraft only.
Elements of EDTO assessment

Compliance demonstration:
Responsibility of the Operator

EDTO Operational Approval

Compliance demonstration:
Responsibility of the Manufacturer

EDTO Type Design & Reliability Approval

Operations
Maintenance
Design
Reliability
Compliance demonstration:
Responsibility of the Operator

EDTO Operational Approval

Compliance demonstration:
Responsibility of the Manufacturer

EDTO Type Design & Reliability Approval
• It is the responsibility of the aircraft manufacturer to obtain the EDTO certification of the aircraft.

• It is a prerequisite to the start of the EDTO operations (EDTO operational approval).

• The Authority in charge of this approval is the Primary Certifying Authority of the manufacturer, i.e. EASA for Airbus aircraft or FAA for Boeing aircraft.

• The EDTO/ETOPS certification of an aircraft is an assessment of the compliance of the candidate aircraft with all the design provisions and reliability objectives of the applicable EDTO/ETOPS criteria (e.g.: EASA AMC 20-6, FAA AC 120-42A or Part 25.1535, ...).
EDTO Type Design Assessment
- Airplanes with more than 2 engines (EDTO certification is NOT required)
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EDTO Type Design standards

EDTO certification process (twin engine aircraft)
- Type Design and Reliability assessment
- IFSD Rate
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- Early EDTO certification

EDTO aircraft documentation
- CMP document / AFM / …

Conclusions
Evolution of EDTO
Type Design Standards

14 CFR 25.1535, Appendix K: ETOPS up to airplane’s capability

FAA Special Conditions 25-ANM-84A (180-min ETOPS at entry into service)

FAA 207 Policy Letter 20-1

• Design for ETOPS
  • Relevant experience (Lessons Learned)
  • ETOPS demonstration testing
  • Problem tracking and resolution
  • Demonstrated reliability

FAA AC 120-42(A) (TP6327)

• Service experience approach
  • Design features added after entry-into-service

1985 1995 2010

• New rule codifies the ETOPS airworthiness standards from AC120-42A, 777 SC 25-ANM-84A and EPL 20-1
AC120-42(A)

AC 120-42A (1988)
Extended Range Operations with Two-Engine Airplanes (ETOPS)

Section 8
Type Design Approval
(Also Appendices 1 and 2)

Propulsion System
CFR 25.901
- Assessment based on engineering and operational judgement
  - For 120-minute approval
    • 250,000 engine hour experience base
    • IFSD rate of 0.05/1,000 hrs with a program to improve toward 0.02.
  - For 180-minute approval
    • One year of service at 120-minutes
    • IFSD rate of 0.02/1,000 hrs achieved.

Airplane Systems
CFR 25.1309
- Electric power for safe flight and landing considering maximum diversion time
- ETOPS System assessments for maximum diversion time
- Cargo fire suppression for maximum diversion time plus 15 minutes

Section 9
In-Service Experience
Appropriate in-service experience

Section 10
Operational Approval
(Also Appendices 3, 4 & 5)

Section 11
Continuing Surveillance

- Assessment of operator’s propulsion system reliability
- Approval of operator’s:
  • Equipment modification status
  • Maintenance procedures
  • Reliability reporting program
- Approval of dispatch controls:
  • MEL
  • Communication/Navigation facilities
  • Fuel and oil planning
  • Alternate airport weather assessment
  • Availability of airplane performance data
- Assessment and approval of flight crew training programs
- Assessment and approval of “Area of Operations” control
**EDTO Configuration**

767*

- **FUEL FEED CONSIDERATION** – dual/single crossfeed valve
- **HYDRAULIC MOTOR GENERATOR** (non-time-limited electrical source, which provides power to captain’s flight and NAV instruments, etc.)
- **APU reliability and start improvements**
- **Additional cargo fire suppression** provides 195 min of cargo fire suppression time
- **Additional equipment cooling monitoring** (allows maintenance verification of proper cooling air flow)
- **Propulsion system reliability enhanced** in-service experience determined improvements

*First model to qualify for 120 minute (1985) and 180 minute (1989) ETOPS*
25-ANM-84

777 ETOPS Special Condition 25-ANM-84

(a) Introduction
(b) Engine Assessment
(c) ETOPS Type Design Assessment
(d) ETOPS Analyses
(e) Additional ETOPS Test Requirements
(f) Problem Tracking System
(g) Reliability Assessment Board (RAB)
(h) Reliability Demonstration Acceptance Criteria
(i) Demonstration of Compliance

(1) Design Requirements Assessment (AC 120-42A)
(2) Relevant Experience Assessment
(3) Design Features
(4) Test Features
(5) Analysis Features
(6) Manufacturing, Maintenance, or Operational (other) Features

(1) Configuration Requirements
(2) Completion of applicable failure analyses
(3) Vibration testing
(4) New technology testing
(5) APU 3,000 cycle test
(6) Engine 3,000 cycle test
(7) Airplane demonstration test, 1,000 CVP
### Comprehensive ETOPS Type Design Standard

<table>
<thead>
<tr>
<th>(a) Introduction</th>
<th>(b) Engine Assessment</th>
<th>(c) ETOPS Type Design Assessment</th>
<th>(d) ETOPS Analyses</th>
<th>(e) Additional ETOPS Test Requirements</th>
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<tr>
<td>(1) Design Requirements Assessment</td>
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<td>(5) APU 3,000 cycle test</td>
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<tr>
<td>(6) Engine 3,000 cycle test (Enhanced post-test inspection)</td>
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<tr>
<td>(7) Airplane ETOPS demonstration test</td>
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</table>
APU designed for 99% in-flight start reliability

Dual crossfeed fuel valves

Improved dry bay

Ultrasonic FQIS

195+ minutes of cargo fire suppression time

Backup generators with increased capability

Propulsion system designed to achieve < 0.010/1000 eng hr IFSD rate

Communication (SATCOM capability)

Navigation

Autoland with engine inoperative

* First model to qualify for 180 minute ETOPS at Service Entry - Early ETOPS (Most variants now have up to 330 minute ETOPS capability)
787 EDTO Type Design
Program Overview

Design Goals

ETOPS Certification Basis

Dedicated ETOPS Testing

Cargo Fire Suppression

Maintenance Task Validations

Operational Procedure Validations
APU designed for 99% in-flight start reliability

Single cross feed fuel valve and an additional fuel balancing system

Improved dry bay

FQIS (capacitance system)

195+ minutes of cargo fire suppression time *

Variable Frequency Starter Generators (VFSG) with increased capability

Propulsion system designed to achieve < 0.010/1000 eng hr IFSD rate

Communication (SATCOM capability)

Navigation

Autoland with engine inoperative

*Airplane systems designed to support up to 330 minute ETOPS capability
EDTO Type Design Assessment
- Airplanes with more than 2 engines (EDTO certification is NOT required)
- Airplanes with 2 engines (EDTO certification is required)

EDTO Type Design standards

EDTO certification process (twin engine aircraft)
- Type Design and Reliability assessment
- IFSD Rate
- Continued monitoring of in-service reliability
- Early EDTO certification

EDTO aircraft documentation
- CMP document / AFM / …

Conclusions
For EDTO, the A/C must be configured, maintained & operated according to the CMP.
For EDTO, the A/C must be configured, maintained & operated according to the CMP
To obtain an EDTO / ETOPS approval of an aircraft, the Manufacturer must show:

- Adequate APU design (start capability within the overall flight envelope)
- Adequate propulsion system reliability
- Adequate APU design (start capability within the overall flight envelope)
- Electrical power source redundancy & capability
- Adequate cargo fire suppression system (capability & reliability)
- Safe flight and landing in EDTO/ETOPS icing conditions
- Adequate cockpit & cabin environment
- Adequate communication systems
- Single engine operation: adequate system redundancy
- Acceptable crew workload (under failure conditions)

Each particular assessment is detailed in the following slides.
EDTO approval of the aircraft
(EDTO/ETOPS certification)

Acceptable Crew Workload
(under failure conditions*)

* = Analysis considers failure conditions for the maximum diversion time/distance
Manufacturer must demonstrate minimum crew workload under failure conditions for the maximum diversion time/distance

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

Flight test campaigns performed to validate acceptable flight crew workload and adequacy of flight crew procedures

- E.g. Single-engine flights combined with various system failure simulations are performed
  1. diversion conducted in emergency electrical configuration,
  2. emergency descent and diversion at FL 100,
  3. failure of autopilot and autothrust etc...
**Enhanced 777-300ER**

**EDTO Test Program**

Airplane Exposure to ETOPS Operational Environments
(Long flights, diversions with degraded systems, diversions to remote airports)

**ETOPS Flight Hours / Cycles**

- WD501: 155:52 / 21
- WD502: 111:20 / 17
Most Time Limited System ≥ EDTO diversion time + 15 min

**Safety Analyses**

Safety analyses (FHA and SSA) are reviewed to consider the maximum permissible diversion time.

Time limitation of the Most Time Limited System (Other than the Cargo Fire Suppression System) must be published in the Flight Manual.

**LIMITATIONS**

Maximum diversion time at planning may not exceed 180 min or 207 min on a case by case basis (as per applicable regulations) at one engine cruising speed, under standard conditions and still air.

The time capability of the cargo fire suppression system is 260 min.

The time capability of all the other ETOPS significant systems exceeds 222 min.
* = Analysis considers failure conditions for the maximum diversion time/distance

Adequate cockpit & cabin environment*
EDTO/ETOPS Design objectives

- Adequate cockpit and cabin environment must be preserved following all combinations of propulsion and electrical system failures which are not shown to be extremely improbable (e.g. in emergency electrical configuration)
- Excess temperature in avionics compartment must be extremely improbable

On Airbus aircraft, pressurization and equipment cooling can be ensured with air from:

- One engine air-bleed system only, or
- The APU air-bleed system up to 22,000 ft
LDA : 7014 ft (2138m)
Surface Condition : Sand treated ice
Latitude: 78° 15’ North

Most northern airport in the world with daily scheduled jet service!
Adequate communication systems
Adequate Communication Systems

- One voice based communication system is required for all ETOPS/EDTO operations up to 180 minutes diversion time.
- SATCOM Voice required for EDTO/ETOPS beyond 180 minutes operations.
- In areas where SATCOM is not available (Polar regions) or does not allow voice communication, a backup voice system is required (HF).

SATCOM voice must be operative for EDTO/ETOPS beyond 180 min operations.
EDTO approval of the aircraft
(EDTO/ETOPS certification)

Electrical power source redundancy & capability
EDTO/ETOPS Design Objectives

- EDTO/ETOPS aircraft must be fitted with at least three reliable independent generators.

- Each generator must be capable of supplying enough services to ensure continued safe flight and landing under adverse operating conditions.

- For EDTO/ETOPS > 180 min:
  - EASA: a 4th generator is required unless the loss of the 3 independent sources is showed to be extremely improbable.
  - FAA: a 4th generator is required to power one cross-feed valve and one fuel boost pump in each tank.
**777 Backup Electrical Power**

**Provides all Essential Loads**

- **Dispatch with Generator or APU/APU Gen Inop**
  - Lose an Engine
  - Lose another Generator or APU/APU Generator
  - Backup Gen Powers All ETOPS Essential Loads

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**ETOPS Essential Loads (abbreviated list)**

- Capt. & F/O Flight Instruments
- EICAS
- Communications – VHF L/R/C, HF L, Intercomm
- Engine Controls, Igniters, Fire Detection/Suppression
- Main Tank Fuel Boost Pumps, Crossfeed Valves
- Cargo Fire Protection
- Wing & Engine Anti-icing, Window Anti-icing Capt.
- Cockpit and Cabin Temperature Control
- ATC Transponder

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**Full-up Airplane**

**Backup Generator Only**
Airbus twin engine aircraft (WB, SA and LR) are equipped with:

- Two engine driven IDG
- One APU driven APU GEN
- One hydraulically driven Constant Speed Motor / Generator (CSM/G) supplied by the main hydraulic circuit (Green or Blue depending on the aircraft family)

A350 aircraft is equipped with
- 4 engine driven VFGs (represent 3 independent electrical sources)
- One APU driven APU GEN

The four generators are independent versus any single cause event (local fire, mechanical damage, uncontained engine failure..)
Adequate Cargo Fire Suppression System (capability & reliability)
EDTO/ETOPS regulations require the cargo fire protection system to cover the maximum approved diversion time and an additional 15 minutes allowance holding and/or approach and landing, e.g.:
- for 120 min EDTO → 135 min minimum protection time needed
- For 180 min EDTO → 195 min minimum protection time needed

Cargo holds protection times are demonstrated by flight tests; this time limitation is identified in the AFM, FCOM and EDTO/ETOPS CMP Document.

A320 Family cargo fire suppression system (2 options) provide at least 135 min and 195 min protection time
- Suitable for both EDTO 120 min and 180 min operations

A330 cargo hold protection time is 260 minutes
- Suitable for EDTO 180 min and for EDTO beyond 180 min operations (Not exceeding 245 min diversion time at AEO speed)
**All Engine Speed with Prevailing Wind and Temperature for ETOPS Beyond 180/207 Minutes**

**Two-engine airplanes**

- No change to current operation
  - Still air distance
  - Standard day
  - Length of diversion +15 minutes
  - One-engine inoperative speed

**Three- and four-engine airplanes**

- No change to current operation

- Length of diversion +15 minutes
- Consider wind and temperature
- All-engine operating speed at cruise altitude

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FAR 121.633(a)
*EASA AMC 20-6, Chapter III Section 7.2.2 (twins only)*

FAR 121.633(b)
*EASA AMC 20-6, Chapter III Section 7.2.3 (twins only)*

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*Engine Inoperative Speed/Altitude for other ETOPS Significant System Time*
Cargo Fire Protection System

LIMITATIONS

Ident.: APP-ETOPS-00005539.0002001 / 26 NOV 09
Criteria: (A330 and (40314 or 40487 or 45435))

EASA APPROVED

Maximum diversion time at planning may not exceed 180 min or 207 min on a case by case basis (as per applicable regulations) at one engine cruising speed, under standard conditions and still air.

The time capability of the cargo fire suppression system is 260 min.

The time capability of all the other ETOPS significant systems exceeds 222 min.
Compliance to K25.1.7 - relevant to 121.633 dispatch

Propulsion Bottles

HRD Bottles (Basic)

LRD Bottles (Basic)

240 min Option

330 min Option

Refer to CMP for actual cargo fire suppression times
Diversion planning based on all engine cruise for ETOPS > 180/207 Minutes *

**Diversion Time per Fire Extinguisher Bottle**

<table>
<thead>
<tr>
<th>Fire Extinguisher Bottle</th>
<th>Diversion Time Capability per Bottle (Minutes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A</td>
<td>60</td>
</tr>
<tr>
<td>2B</td>
<td>60</td>
</tr>
<tr>
<td>2C</td>
<td>60</td>
</tr>
<tr>
<td>2D</td>
<td>47</td>
</tr>
<tr>
<td>2E</td>
<td>64</td>
</tr>
</tbody>
</table>

High rate discharge bottles 1A and 1B provide initial 15 minutes of suppression time.

**Bottle Configuration**

<table>
<thead>
<tr>
<th>Bottle Configuration</th>
<th>Suppression Time</th>
<th>ETOPS Capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2A, 2B, 2C</td>
<td>195 minutes</td>
<td>Up to 180 minutes</td>
</tr>
<tr>
<td>2A, 2B, 2C, 2D</td>
<td>242 minutes</td>
<td>207 minutes</td>
</tr>
<tr>
<td>2A, 2B, 2C, 2D</td>
<td>242 minutes</td>
<td>240 minutes</td>
</tr>
<tr>
<td>2A, 2B, 2C, 2D, 2E</td>
<td>306 minutes</td>
<td>Up to 330 minutes</td>
</tr>
</tbody>
</table>

* Engine out, still air minus 15 min
* All engine, with winds minus 15 min
EDTO approval of the aircraft
(EDTO/ETOPS certification)

* = Analysis considers failure conditions for the maximum diversion time/distance
• Fuel cross feed to operative engine during single engine operation (twin engine aircraft) must be protected against single malfunctions

• Engine operation: Effect of turbulence and negative “G” must be evaluated if:
  - fuel boost pumps are not powered (e.g. limitation in emergency electrical configuration)
  - the loss of all fuel boost pumps is not showed to be extremely improbable
Low Fuel Alert considerations

Low Fuel Alerting functions are specifically required by new EDTO/ETOPS regulations.

Example for A330:

\[ \text{EXTRA} = \text{DEST EFOB} - (\text{ALTN} + \text{FINAL}) \]

If DEST EFOB becomes lower than MIN DEST FOB:

- DEST EFOB turns amber on MCDU pages
- \text{DEST EFOB BELOW MIN} message (except in T/O or CLB)
EDTO approval of the aircraft (EDTO/ETOPS certification)

Single engine operation: adequate system redundancy
**Adequate System Redundancy**

In case of engine failure, the remaining electrical, hydraulic and pneumatic power (as applicable) must be sufficient for safe flight and landing.

Example for twin engine aircraft with 1 Elec. Gen / 1 Bleed / 2 Hyd. Pumps per engine:

<table>
<thead>
<tr>
<th>Systems</th>
<th>Normal</th>
<th>One engine shutdown</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Hydraulic</strong></td>
<td>3 systems 1 RAT backup</td>
<td>2 systems 1 RAT backup</td>
</tr>
<tr>
<td><strong>Electrical</strong></td>
<td>4 generators - 2 engines - 1 APU - 1 Emergency Gen</td>
<td>3 generators - 1 engine - 1 APU - 1 Emergency Gen</td>
</tr>
<tr>
<td><strong>Pneumatic</strong></td>
<td>3 air bleed sources - 2 engines - 1 APU</td>
<td>2 air bleed sources - 1 engine - 1 APU</td>
</tr>
</tbody>
</table>
EDTO approval of the aircraft
(EDTO/ETOPS certification)

Safe flight and landing in ETOPS icing conditions
Adequate Ice Protection

Performance and handling effects of ice accretion on unprotected surfaces must be accounted for.

The following functions must be available in “emergency electrical” configuration (i.e. only 1 elec.gen):

- Engine air-intake anti-ice
- Wing anti-ice
- At least one alpha probe anti-ice
- At least one pitot probe de-ice
Adequate APU design (start capability within the overall flight envelope)
ETOPS Design Objectives

APU installation should meet normal certification requirements
APU should meet additional EDTO/ETOPS requirements needed to demonstrate its intended function (e.g. third electrical generator)

- Demonstrated in-flight start capability: 95%
- Demonstrated run reliability: 10 E-3 / APU operating hour failure rate (MTBF >1000 hrs)
- Compliance with above reliability objectives must be demonstrated through in service experience and Early EDTO/ETOPS demonstration in case of EDTO at EIS

APU Design

- APU must be able to be started up to the max operating altitude (for A/C with APU not running in EDTO sectors)
- APU reliability must be adequate to EDTO operations
EDTO approval of the aircraft
(EDTO/ETOPS certification)

Adequate Propulsion System Reliability

Single engine operation: adequate system redundancy
EDTO/ETOPS Design Objectives:

- There is no EDTO specific design criteria on the powerplant, except:
  - EDTO engines must be fitted with an oil tank filler cap
  - Failures (contained or not) of propulsion system should not adversely affect remaining system or equipment
  - Engines must meet EDTO reliability objectives (IFSD target rate): Compliance with these reliability objectives must be demonstrated through in service experience and Early EDTO/ETOPS demonstration in case of EDTO at EIS

Review of propulsion system data & in-service experience should be conducted:

- Prior to first EDTO/ETOPS Type Design approval; and
- On a continuing basis thereafter

Propulsion system should achieve an in-flight shutdown (IFSD) rate of:

- 0.05 / 1000 engine hours for EDTO 120 min
- 0.02 / 1000 engine hours for EDTO 180 min
- 0.01 / 1000 engine hours for EDTO beyond 180 min
- Rate computed based on world fleet data, on a 12-month rolling average
In-flight shutdown (IFSD) means, for ETOPS only, when an engine ceases to function (when the airplane is airborne) and is shutdown, whether self induced, flight crew initiated or caused by an external influence.

The 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 airborne 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 shutdown.

This definition is fully harmonized with FAA definition (AC 120-42B)
- Similar definition to AMC 20-6 Rev 2

These events as well as engine failures occurring before take-off decision speed or after touch-down, although not counted as IFSD, are reviewed & reported in the frame of continued airworthiness for ETOPS.
EDTO/ETOPS Type Design approval requirements for IFSD ( Twins):

- EDTO 120 min: 0.050/1000 EH
- EDTO 180 min: 0.020/1000 EH
- EDTO beyond 180 min: 0.010/1000 EH

Based on world fleet 12 month rolling average
12-Month Average as of March, 2014

World fleet IFSD
Rates of Boeing Twins

*High IFSD rate is insignificant - due to only one or two IFSDs in the period and few flight hours.
For EDTO, the A/C must be configured, maintained & operated according to the CMP
In-service event

EDTO-significant ATA chapter / system

NO

EDTO-significant function / sub-system / component

NO

Event consequences potentially more important for EDT0

NO

Corrective actions already taken in the scope of Continued Airworthiness are adequate for EDT0

YES

=> Specific corrective action needed for EDT0

NO

Non EDT0 related event

NO further action

YES
ETOPS certification regulations give two possibilities to get an ETOPS Certification

- **In-service approval**
  - Requires in-service experience with candidate aircraft
    - EASA: up to 100,000 engine hours
    - FAA: up to 250,000 engine hours

- **Early ETOPS Approval**
  - Enables to get an ETOPS certification with
  - Process-based approach requiring extensive maturity and reliability demonstrations with candidate aircraft
  - Involves close monitoring of the reliability demonstration by the Authorities
ETOPS Philosophy

Preclude and Protect Diversions

Early-ETOPS Type Design Certification Process

<table>
<thead>
<tr>
<th>EASA AMC 20-6 Ch II – Section 6.2</th>
<th>FAR Part 25.1535 &amp; App. K</th>
</tr>
</thead>
</table>

1. Design for ETOPS
2. Relevant Experience (Lessons Learned)
3. Maintenance & Operations Procedures Validation
4. ETOPS Testing
   - APU & engine 3,000 Cy test
   - Demonstration Flight Tests
5. Problem Tracking and Resolution

The **5 Main Elements** of Early-ETOPS Ensure ETOPS Capability at Service Entry
Each propulsion system (engine and airplane accessories) completed 3000 simulated flight cycles

- Electrical generator and hydraulic systems will be fully loaded
- Engine intentionally imbalanced to validate engine accessories durability
- Operational thrust reverser
- (3) 330 minute MCT diversion cycles
- Full post test tear down and inspection

Compliance to K25.2.2(d)
787 APU ETOPS Design Approval

ETOPS requirements part of basic design specification

3000 Cycle endurance test
   Electrical generators fully loaded
   Post test tear down and inspection

Design for in-flight start reliability
   200 simulated in-flight altitude starts including cold soak
   Collected APU in-flight start data during 787 flight test program

Alaska cold weather demonstration

APU maintenance task validations
   3 airlines, 122 tasks validated

Compliance to K25.2.2(c) and (f)
787 APU In-flight Start Performance

Initial Operator Service Experience and Boeing Flight Test

ETOPS Operators
(§121.374(l) APU in-flight start monitoring program)

In-service In-flight APU Starts due to Non-normal Events

Boeing Production Flight Tests
(Loaded Generators)

Boeing ETOPS Testing, and Function & Reliability Testing
(Loaded Generators)

Through February 28, 2014

(Cold soaked start attempts near end of long flights) 483

*Only includes data reported from Operators to Boeing

Number of APU In-flight Start Attempts

APU Start on 1st Attempt (or number of attempts not reported)
APU Start on 2nd or 3rd Attempt
APU Failed to Start

ICAO EDTO Course - Aircraft Certification 63
Demonstration Flight Tests

Multiple 345 minute engine-out diversion demonstrations

- MCT (2 repeated on same engine)
- Decompression at 10,000 ft
- Driftdown profile

Multiple degraded system diversion scenarios (345 minutes)

- Multiple cycles from humid environment to cold soak at altitude
- Maximum duration flight demonstration

Use of in-service manuals and procedures

Post test inspection

Compliance to K25.2.2(g)
### Flight Test Scenarios and Statistics Summary*

<table>
<thead>
<tr>
<th>Scenarios/Other</th>
<th>Trent 1000</th>
<th>Trent 1000 Package B</th>
<th>GEnx</th>
<th>GEnx PIP I</th>
<th>Totals</th>
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<tbody>
<tr>
<td>Airplanes</td>
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<td>1</td>
<td>2</td>
<td>1</td>
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<td>Flights</td>
<td>29</td>
<td>2</td>
<td>31</td>
<td>2</td>
<td>64</td>
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<tr>
<td>Flight hours</td>
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<td>14</td>
<td>204</td>
<td>13</td>
<td>448*</td>
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<tr>
<td>Humidity cycles</td>
<td>10</td>
<td>–</td>
<td>10</td>
<td>–</td>
<td>20</td>
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<tr>
<td>Engine-out conditions (345 minutes)</td>
<td>8</td>
<td>2</td>
<td>13</td>
<td>2</td>
<td>25</td>
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<tr>
<td>Degraded electrical (345 minutes)</td>
<td>–</td>
<td>–</td>
<td>8</td>
<td>–</td>
<td>14</td>
</tr>
<tr>
<td>Single VFSG</td>
<td>1</td>
<td>–</td>
<td>2</td>
<td>–</td>
<td>3</td>
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<tr>
<td>APU only</td>
<td>1</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>1</td>
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<tr>
<td>Degraded ECS/PECS (345 minutes)</td>
<td>6</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>6</td>
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<tr>
<td>Max ETOPS mission</td>
<td>18:24</td>
<td>–</td>
<td>19:12</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Diversion airports</td>
<td>3</td>
<td>–</td>
<td>–</td>
<td>–</td>
<td>3</td>
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<tr>
<td>Post-test inspections</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>–</td>
</tr>
</tbody>
</table>

*6,775 total 787-8 flight test hours thru November, 2012*
• All ETOPS significant system *maintenance* and *operational* tasks validated as part of ETOPS Type-Design compliance

• Airplane and engine tasks validated by several means
  • Desk top validation
  • Lab test
  • Boeing and RR/GE ground tests
  • Boeing airplane flight tests

• ETOPS Propulsion & APU 3000-cycle tests
  • Normal scheduled *maintenance* that would be expected to occur during 3000 cycles

• Boeing ETOPS Airplane Demonstration Flight Test
  • Test airplanes *operated* and *maintained* using recommended procedures

Compliance to K25.2.2(c)
Examples of Operational Procedures Validated: Fuel System

- Fuel Leak
- Fuel Press Eng L, R
- Fuel Pump Center L, R
- Fuel Pump L, Aft, Fwd
- Fuel Pump L, Aft, Fwd
- Fuel Qty Low
- Fuel Temp High
- Fuel Temp Low
- Fuel Valve APU

Compliance to K25.2.2(c)
EDTO Type Design Assessment
  - Airplanes with more than 2 engines (EDTO certification is NOT required)
  - Airplanes with 2 engines (EDTO certification is required)

EDTO Type Design standards

EDTO certification process (twin engine aircraft)
  - Type Design and Reliability assessment
  - IFSD Rate
  - Continued monitoring of in-service reliability
  - Early EDTO certification

EDTO aircraft documentation
  - CMP document / AFM / …

Conclusions
The EDTO/ETOPS CMP Document defines:

- The configuration of the airframe, the engines and the APU for EDTO
- The maintenance requirements specific to EDTO (also found in the MRBR)
- The procedures specific to EDTO (also found in the AFM and FCOM)
- The dispatch limitations specific to EDTO (also found in the MMEL)

For EDTO, the aircraft must be configured, maintained and operated according to the CMP Document.
For Entry into Service:
- Flight Test Results
- Simulation
- Syst. Safety Assmt.
- A/C Related Events

For Aircraft in-service:
- Reliability trends
- Events
- Modifications
- Other A/C Rel.events

EDTO/ETOPS CMP Document

EDTOPS Maintenance Practices
EDTOPS Critical / Significant Items
EASA Mature Product Policy

- The EASA RTB declares a product mature.
- Once mature, the RTB is replaced by a yearly reliability report submitted to the RTB Chairman and the aircraft PCM (Project Certification Manager) for review.
  - This report shall contain all relevant information to judge that the ETOPS fleet is operating in accordance with the reliability objectives.
  - RTB Chairman may call for a specific meeting in case of need.
- CMP revisions may be required in case of significant issues affecting the ETOPS fleet reliability.

FAA “frozen CMP” policy

- According to FAA policy, original version of CMP is frozen.
- Any subsequent revision found necessary by the reliability monitoring process is dealt with by issuing Airworthiness Directives (ADs).
## Approved Aircraft Model / Engine combinations

<table>
<thead>
<tr>
<th>Aircraft Model</th>
<th>Engine</th>
<th>Basic or Intermix</th>
<th>Maximum diversion time (Minutes)</th>
<th>Areas of operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>A330-201</td>
<td>CF6-80E1A2</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
</tr>
<tr>
<td>A330-202</td>
<td>CF6-80E1A4</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
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<tr>
<td>A330-202</td>
<td>CF6-80E1A2</td>
<td>Intermix</td>
<td>180</td>
<td>Normal</td>
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<tr>
<td>A330-203</td>
<td>CF6-80E1A3</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
</tr>
<tr>
<td>A330-223</td>
<td>PW4168A</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
</tr>
<tr>
<td>A330-243</td>
<td>TRENT772B-60</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
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<tr>
<td>A330-301</td>
<td>CF6-80E1A2</td>
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<tr>
<td>A330-302</td>
<td>CF6-80E1A4</td>
<td>Basic</td>
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<td>Normal</td>
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<tr>
<td>A330-303</td>
<td>CF6-80E1A3</td>
<td>Basic</td>
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<td>Normal</td>
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<tr>
<td>A330-321</td>
<td>PW4164</td>
<td>Basic</td>
<td>180</td>
<td>Normal</td>
</tr>
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<td>A330-322</td>
<td>PW4168</td>
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<td>A330-323</td>
<td>PW4168A</td>
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<td>A330-341</td>
<td>TRENT768-60</td>
<td>Basic</td>
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<td>Normal</td>
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<td>A330-342</td>
<td>TRENT772-60</td>
<td>Basic</td>
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<td>Normal</td>
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<tr>
<td>A330-343</td>
<td>TRENT772B-60</td>
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<tr>
<td>A330-343</td>
<td>TRENT772-60</td>
<td>Intermix</td>
<td>180</td>
<td>Normal</td>
</tr>
</tbody>
</table>

**Approved Airplane / Engine combinations**

**Maximum authorized Diversion Time**
System Design Capacity (Time Limited System, TLS)

Maximum authorized Diversion Time
### ATA 21

**CMP Standards applicable to A330-233**

**MSN:** L-6170, L-7352

**Fitted with:** FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM

**MODS:** MOD 69079 OR MOD 46199

<table>
<thead>
<tr>
<th>Configuration item n°</th>
<th>21-1-0000-002</th>
<th>Revision n°14</th>
<th>Area of Operation: Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Diversion Time Range:</strong></td>
<td>from 60 to 180 min</td>
<td>Compliance Schedule: Priority</td>
<td></td>
</tr>
<tr>
<td>Introduce Improved Packs and temperature Sensors</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solutions: n°1: LIEBHERR SB 9105A-21-01 AND LIEBHERR SB 955A-21-01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>n°2: MOD 42518 AND MOD 42529</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>n°3: SB 21-3010</td>
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<table>
<thead>
<tr>
<th>Maintenance item n°</th>
<th>21-2-0000-001</th>
<th>Revision n°7</th>
<th>Area of Operation: Normal</th>
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</thead>
<tbody>
<tr>
<td><strong>Diversion Time Range:</strong></td>
<td>from 60 to 180 min</td>
<td>Compliance Schedule: Interval. Not to exceed 2500 Flight hours</td>
<td></td>
</tr>
<tr>
<td>Lower deck cargo compartment ventilation and cooling/heating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational check to verify automatic closing of isolation valves and shut-off of extraction fans in case of smoke warning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solutions: n°1: MPD 212809-01</td>
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</table>

<table>
<thead>
<tr>
<th>Maintenance item n°</th>
<th>21-2-0000-002</th>
<th>Revision n°7</th>
<th>Area of Operation: Normal</th>
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<tbody>
<tr>
<td><strong>Diversion Time Range:</strong></td>
<td>from 60 to 180 min</td>
<td>Compliance Schedule: Interval. Not to exceed 2500 Flight hours</td>
<td></td>
</tr>
<tr>
<td>Lower cargo deck cargo compartment ventilation and cooling/heating</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operational check to verify automatic closing of cold air valve in case of smoke warning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
<td></td>
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<tr>
<td>Solutions: n°1: MPD 212809-02</td>
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<table>
<thead>
<tr>
<th>Procedure item n°</th>
<th>21-3-0000-001</th>
<th>Revision n°1</th>
<th>Area of Operation: Normal</th>
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<tbody>
<tr>
<td><strong>Diversion Time Range:</strong></td>
<td>from 60 to 180 min</td>
<td>Compliance Schedule: Not Applicable</td>
<td></td>
</tr>
<tr>
<td>Procedure to use APU bleed for pressurization in case of failure of both engine bleeds</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Flight altitude is limited to 22000 ft</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solutions: n°1: FCOM</td>
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</tbody>
</table>

No Dispatch Standards under this ATA chapter for concerned aircraft / configuration.
ATA 21
CMP Standards applicable to A330-223
MSN: L-6870, L-7332
Fitted with: FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM
MOD/SB: MOD 40097 OR MOD 45199

Configuration item n°: 21-1-0900-092
Revision n°: 14
Area of Operation: Normal

Diversion Time Range: from 60 to 180 min
Compliance Schedule: Priority

Lower cargo deck cargo compartment ventilation and cooling/heating.
Operational check to verify automatic closing of cold air valve in case of smoke warning.
Cross Reference: N/A
Solutions: n°1: MPD 212809-02

Procedure item n°: 21-3-0000-001
Revision n°: 1
Area of Operation: Normal

Diversion Time Range: from 60 to 180 min
Compliance Schedule: Not Applicable
Procedure to use APU bleed for pressurization in case of failure of both engine bleeds.
Flight altitude is limited to 22000 ft.
Cross Reference: N/A
Solutions: n°1: FCAM

No Dispatch Standards under this ATA chapter for concerned aircraft / configuration.

Header of the page:
- Shows ATA
- Reflects applicability (MSN)
- Specific configuration for this ATA (or Basic)
#### Item contains:

- **Chapter:**
  1. Configuration
  2. Maintenance
  3. Procedures
  4. Dispatch
- **Diversion Time Range**
- **Compliance Schedule** (for Conf. Maint. Items)
- **Description**
- **Solution(s)**

### ATA 21

**CMP Standards applicable to A330-223**

**MSN:** L-6870, L-7332

**Fitted with:** FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM

**MOD/BB:** MOD 42628 OR MOD 46199

---

<table>
<thead>
<tr>
<th>Item</th>
<th>Chapter:</th>
<th>Diversion Time Range</th>
<th>Compliance Schedule</th>
</tr>
</thead>
<tbody>
<tr>
<td>21-1-0000-002</td>
<td>1- Configuration</td>
<td>from 60 to 180 min</td>
<td>Priority</td>
</tr>
</tbody>
</table>

- **Introduction:** Improved Packs and temperature Sensors.
- **Cross Reference:** N/A

**Solutions:**

- n°1: LIEBHERR SB 9105A-21-01 AND LIEBHERR SB 956A-21-01
- n°2: MOD 42628 AND MOD 42629
- n°3: SB 21-3010

---

**Conf. item n°:** 21-1-0000-002

**Revision n°14**

**Area of Operation:** Normal

**Compliance Schedule:**

- **Priority**

---

**Diversion Time Range:**

- from 60 to 180 min

**Cross Reference:** N/A

**Operational Check:** Verify automatic closing of isolation valves and shut off of extraction fans in case of smoke warning.
<table>
<thead>
<tr>
<th>ATA 21</th>
<th>CMP Standards applicable to A330-223</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSN: L-6870, L-7332</td>
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<tr>
<td>Fitted with: FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM</td>
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<tr>
<td>MOD/98: MOD-0099 CR MOD-46199</td>
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</tbody>
</table>

**Configuration item n°: 21-1-0000-002**  
**Revision n°: 14**  
**Area of Operation: Normal**

<table>
<thead>
<tr>
<th>Diversion Time Range: from 60 to 180 min</th>
<th>Compliance Schedule: Priority</th>
</tr>
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<tbody>
<tr>
<td>Introduce improved Packs and temperature Sensors.</td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
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<tr>
<td>Solutions: n° 1: LIEBHERR SB 910CA.21-01 AND LIEBHERR SB 950CA.21-01</td>
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<tr>
<td>n° 2: MOD 42028 AND MOD 42029</td>
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<td>n° 3: SB 21-2010</td>
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</table>

**Maintenance item n°: 21-2-0000-001**  
**Revision n°: 7**  
**Area of Operation: Normal**

<table>
<thead>
<tr>
<th>Diversion Time Range: from 60 to 180 min</th>
<th>Compliance Schedule: Interval. Not to exceed 2500 Flight hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower deck cargo compartment ventilation and cooling/heating</td>
<td></td>
</tr>
<tr>
<td>Operational check to verify automatic closing of isolation valves and shut-off of extraction fans in case of smoke warning</td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
</tr>
<tr>
<td>Solutions: n° 1: MPD 212800-01</td>
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</tbody>
</table>

**Maintenance item n°: 21-2-0000-002**  
**Revision n°: 7**  
**Area of Operation: Normal**

<table>
<thead>
<tr>
<th>Diversion Time Range: from 60 to 180 min</th>
<th>Compliance Schedule: Interval. Not to exceed 2500 Flight hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower cargo deck cargo compartment ventilation and cooling/heating</td>
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</tr>
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<td>Operational check to verify automatic closing of isolation valves and shut-off of extraction fans in case of smoke warning</td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
</tr>
<tr>
<td>Solutions: n° 1: MPD</td>
<td></td>
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</table>

**Procedure item**

<table>
<thead>
<tr>
<th>Diversion Time Range: from 60 to 180 min</th>
<th>Compliance Schedule: Not Applicable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Procedure to use APU bleed for Pressurization in case of failure of both engine bleeds. Flight altitude is limited to 22000 ft.</td>
<td></td>
</tr>
<tr>
<td>Cross Reference: N/A</td>
<td></td>
</tr>
<tr>
<td>Solutions: n° 1: FCOM</td>
<td></td>
</tr>
</tbody>
</table>

No Dispatch Standards under this ATA chapter for concerned aircraft / configuration.
### CMP Document – Airbus CMP page layout

**ATA 21**
- CMP Standards applicable to A330-233
- MSN: L-6870, L-7332
- Fitted with: FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM
- MOD/SB: MOD-00097 GR MOD-46199

#### Configuration item no.: 21-1-0000-002
<table>
<thead>
<tr>
<th>Revision n°</th>
<th>Area of Operation: Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>14</td>
<td></td>
</tr>
</tbody>
</table>

**Divergence Time Range:**
- from 60 to 180 min

**Compliance Schedule:**
- Priority

Introduce Improved Packs and temperature Sensors.

**Cross Reference:** N/A

**Solutions:**
- n°1: LIEBHERR SB 955A-21-01 AND LIEBHERR SB 955A-21-01
- n°2: MOD 42020 AND MOD 42029
- n°3: SB 21-2010

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#### Maintenance item no.: 21-2-0000-001
<table>
<thead>
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<th>Revision n°</th>
<th>Area of Operation: Normal</th>
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</thead>
<tbody>
<tr>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

**Divergence Time Range:**
- from 60 to 180 min

**Compliance Schedule:**
- Interval. Not to exceed 2500 Flight hours

Lower deck cargo compartment ventilation and cooling/heating.

**Operational check to verify automatic closure of isolation valves and shut. off of extraction fans in case of smoke warning.**

**Cross Reference:** N/A

**Solutions:**
- n°1: MPD 212609-01

---

#### Maintenance item no.: 21-2-0000-002
<table>
<thead>
<tr>
<th>Revision n°</th>
<th>Area of Operation: Normal</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td></td>
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</tbody>
</table>

**Divergence Time Range:**
- from 60 to 180 min

**Compliance Schedule:**
- Interval. Not to exceed 2500 Flight hours

Lower cargo deck cargo compartment ventilation and cooling/heating.

**Operational check to verify automatic closure of isolation valves and shut. off of extraction fans in case of smoke warning.**

**Cross Reference:** N/A

**Solutions:**
- n°1: MPD 212609-01

---

No Dispatch Standards under this ATA chapter for concerned aircraft / configuration.

---

The CMP document defines the ETOPS/EDTO configuration in terms of Modifications or Service bulletin references, but does not mention the corresponding P/N’s.

The Parts List is a **tool to assist the operator in identifying the P/N's** which are:

- NOT approved for EDTO (P/N's not to be fitted on EDTO aircraft)
- The minimum standards required for proper EDTO configuration

The EDTO Parts List reflects the latest revision of the EDTO CMP document.

Except otherwise stated, **any P/N above the minimum standard P/N is considered approved for EDTO**.

The Parts List is not an approved document; in case of any doubt, the CMP should be used as the ONLY reference for ascertaining the required EDTO configuration.
EDTO aircraft documentation
EDTO parts identification: Parts list & IPC

1 - Configuration items
2 - Maintenance items

For each item: list of MOD/ SB/ VSB

Pre-MOD P/N

Post-MOD P/N

Parts
NOT APPROVED
for ETOPS

Parts
NOT APPROVED
for ETOPS after
specified end date

Parts
APPROVED
(mandatory)
for ETOPS

IPC

Part List

MOD
SB
VSB

Parts NOT APPROVED for ETOPS

Parts NOT APPROVED for ETOPS after specified end date

Parts APPROVED (mandatory) for ETOPS
Approved AFM ETOPS Supplement

- Appendices & Supplements Extended Operations (ETOPS)
- Applies to ETOPS operated airplanes
- Identifies limitations for ETOPS
  - Max Diversion Time
  - Time capabilities of cargo fire protection system and other most limiting ETOPS significant system
Identifies additional diversion cases for ETOPS in case of:
- One generator remains available; or
- One main generator remains available, combined with low pressure / low level or overheat of green hydraulic.

Confirms applicability of procedures listed in AFM Chapter Emergency Procedures & Abnormal Procedures (following failures & normal procedures).

Provides reference to applicable performance data:
- AFM module AFM-OCTO (determination of performance)
- FCOM Chapters PER-OEI-GEN-06 (Single engine operation)
This finding does not constitute approval to conduct extended range operations.

EXTENDED RANGE OPERATIONS

The type design reliability and performance of this airplane/engine combination has been evaluated in accordance with FAA Advisory Circular 120-42A and found suitable for a maximum of 180-minutes extended range operations when configured in accordance with Boeing Document D6T11604 “CONFIGURATION, MAINTENANCE And PROCEDURES FOR EXTENDED RANGE OPERATIONS”.

This finding does not constitute approval to conduct extended range operations.
Extended Range Operations

The type design reliability and performance of this airplane/engine combination has been evaluated in accordance with 14 CFR 25.1535 and found suitable for greater than 180 minutes extended operations (ETOPS) when configured in accordance with Boeing Document D021Z002 "MODEL 787 ETOPS Configuration, Maintenance, and Procedures". The actual maximum approved diversion time for this airplane may be less based on its most limiting system time capability. This finding does not constitute approval to conduct extended operations.

System Time Capabilities:

The most limiting ETOPS significant system time (other than cargo fire suppression) is 345 minutes.

The most limiting cargo fire suppression system time is ### minutes.
The Operator’s MEL must include the MMEL restrictions for ETOPS operations:

- The MEL is a document agreed/approved by the relevant National Authorities.
- The MEL cannot be less restrictive than the MMEL.

### Dispatch restrictions specific to ETOPS

Dispatch restrictions specific to ETOPS are identified in the basic MMEL.

- The MEL is a document agreed/approved by the relevant National Authorities.
- The MEL cannot be less restrictive than the MMEL.

**Example:**

<table>
<thead>
<tr>
<th>24-25-02</th>
<th>Manual Transfer (ALTN Function) of AC ESS FEED Control to AC BUS 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ident.: 24-25-0000711.0001001</td>
<td>22 MAR 10</td>
</tr>
<tr>
<td>Applicable to: ALL</td>
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<table>
<thead>
<tr>
<th>24-25-02A</th>
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</thead>
</table>

<table>
<thead>
<tr>
<th>Repair interval</th>
<th>Nbr installed</th>
<th>Nbr required</th>
<th>Placard</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>1</td>
<td>0</td>
<td>Yes</td>
</tr>
</tbody>
</table>

*(o)* May be inoperative provided that:

1. ETOPS is not conducted, and
2. The AC ESS FEED pb-sw is in the norm position, and
3. The three DC TIE contactors are operative.
EDTO Type Design Assessment
- Airplanes with more than 2 engines (EDTO certification is NOT required)
- Airplanes with 2 engines (EDTO certification is required)

EDTO Type Design standards

EDTO certification process (twin engine aircraft)
- Type Design and Reliability assessment
- IFSD Rate
- Continued monitoring of in-service reliability
- Early EDTO certification

EDTO aircraft documentation
- CMP document / AFM / …

Conclusions
• EDTO Type Design and Reliability Approval (Certification) is under the responsibility of the aircraft manufacturer and is granted by the Primary Certification Authority

  – This EDTO certification is required only for Twin engine aircraft

  – Airplanes with more than 2 engines must be assessed to identify / confirm the capability of relevant Time Limited System(s):

    • Capability of Cargo Fire Suppression system usually defines the applicable limitation for EDTO

    • There are no additional maintenance requirements nor additional certification requirements

• EDTO Certification is a two-step process:

  - ETOPS Type Design Review: Compliance against applicable design requirement

  - ETOPS Reliability Review: Assessment of A/C Systems, APU & engines’ reliability

• When granted, EDTO certification is supported by:

  - EDTO/ETOPS CMP Document (Approved document regularly revised)

  - Aircraft and Engine TCDS

  - AFM, MMEL, MRBR

  - Other non-approved documents or tools: FCOM, MPD, IPC,…
• Once granted, EDTO certifications are maintained through EDTO Continued Airworthiness activities such as:
  - Review of in-service events
  - Review of engines’ IFSD rates

- Conclusions of Continued Airworthiness reviews are included in new revisions of ETOPS CMP Document or dedicated ADs.

- Most of current large transport aircraft fitted with more than 2 engines have an EDTO capability sized by their Cargo Fire Suppression System.

- Most of current large transport aircraft fitted with 2 engines are certified for 180 min EDTO or greater.
  - EDTO>180 min capabilities are usually offered by “long range” Twin engine aircraft

*(see next slides for current EDTO capabilities of Airbus & Boeing aircraft)*
Airbus twin-engine aircraft models are approved for EDTO

- All models approved for ETOPS 180 min
- Similar approvals targeted for A320NEO Family models

- ETOPS beyond 180 min for all A330 Pax models
  - 1700 NM, equivalent to ~240 min (ISA, Still Air)
- A330-200F models approved for ETOPS 180 min

- ETOPS beyond 180 min approval targeted
  - 2500 NM, equivalent to ~370 min (ISA, Still Air)
All Airbus four-engine aircraft models are capable of EDTO

- **A380**
  - 240 min Cargo Fire Suppression capability

- **A340-200 / -300**
  - 260 min Cargo Fire Suppression capability

- **A340-500 / -600**
  - 285 min Cargo Fire Suppression capability
ETOPS Design Capabilities and Objectives Summary

<table>
<thead>
<tr>
<th>Aircraft Type</th>
<th>Current Capability</th>
<th>Future Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>737NG</td>
<td>180 min</td>
<td></td>
</tr>
<tr>
<td>737 MAX</td>
<td>180 min</td>
<td></td>
</tr>
<tr>
<td>757</td>
<td>180 min</td>
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</tr>
<tr>
<td>767</td>
<td>180 min</td>
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</tr>
<tr>
<td>747-8I</td>
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</tr>
<tr>
<td>777-300ER, 200LR *</td>
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<tr>
<td>777 Freighter *</td>
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<tr>
<td>777-300</td>
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<tr>
<td>777-200ER/GE *</td>
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<td>787-9</td>
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</tbody>
</table>

* 207 for EASA (330 pending)
Module 4
EDTO Aircraft Certification Considerations
Thank You!!