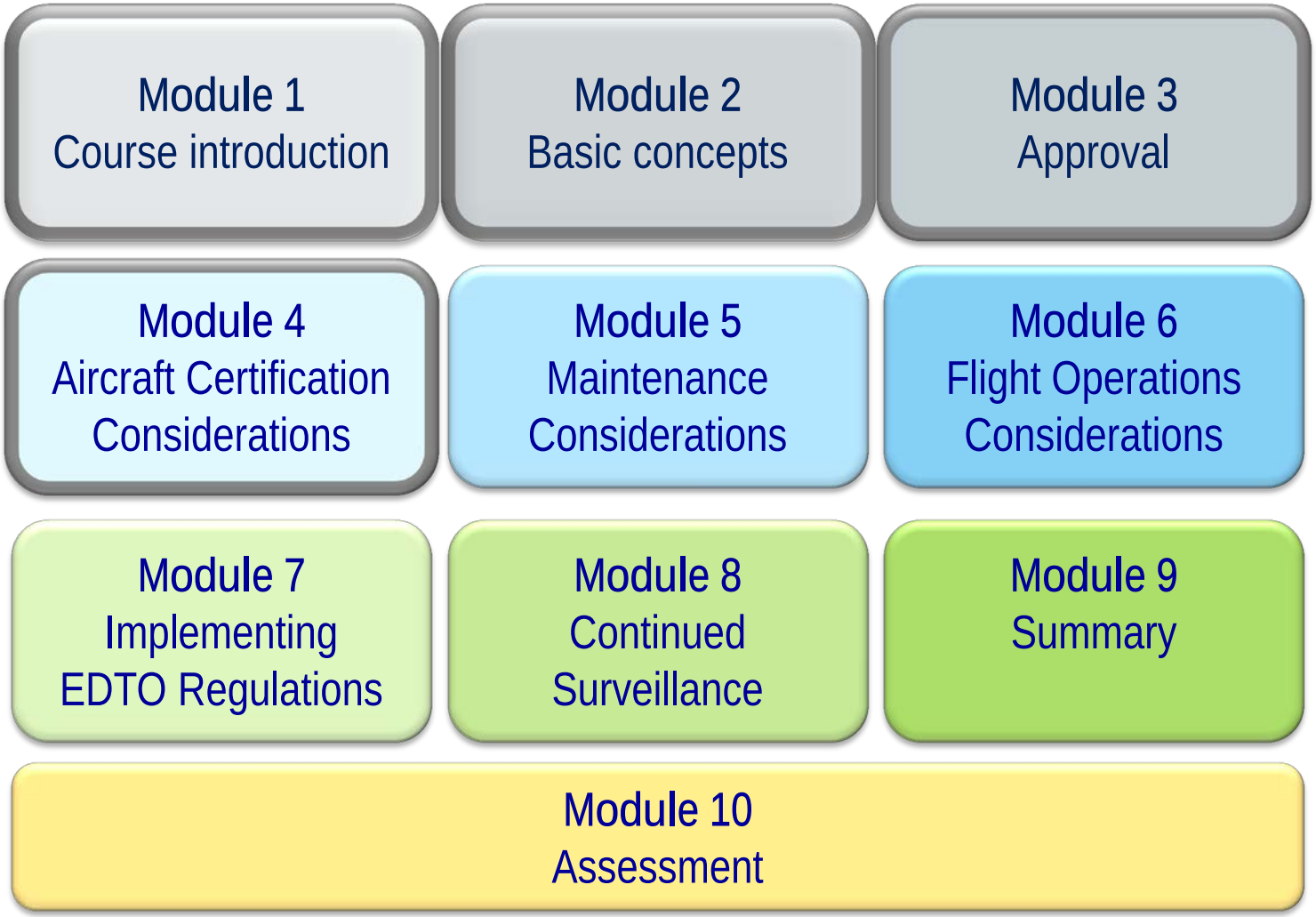
ICAO UNITING AVIATION

EDTO Workshop

Module N° 4 –Aircraft certification considerations

Course Structure



Objectives

- *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.*

Outline

- 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 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

Agenda

- 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

Certification & operational approval

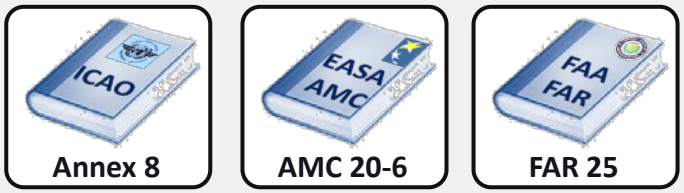
To operate beyond threshold, two conditions must be met:

Aircraft Certification

(may not be required under certain conditions)

Applicant:

MANUFACTURER



Prime Certification Authority

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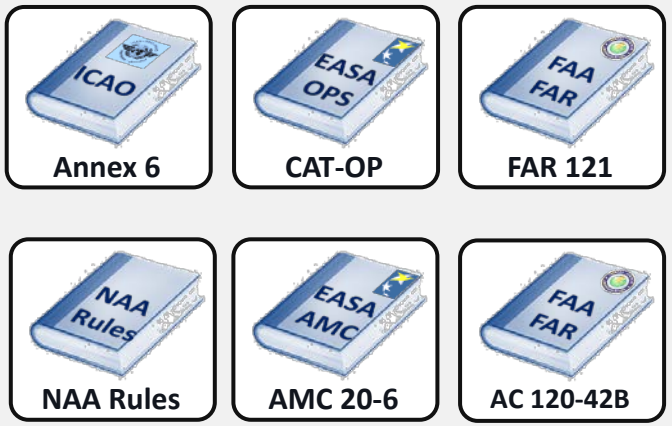
Validation Authorities

Operational Approval

Applicant:

OPERATOR



National Aviation Authority

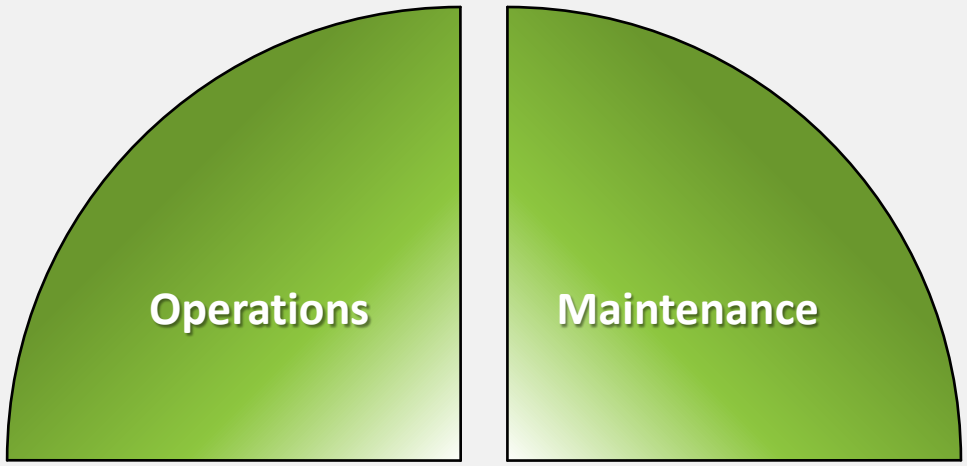
Must be obtained before approval of Operator for EDTO

EDTO Type Design Assessment

Airplanes with more than 2 engines

- 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.*

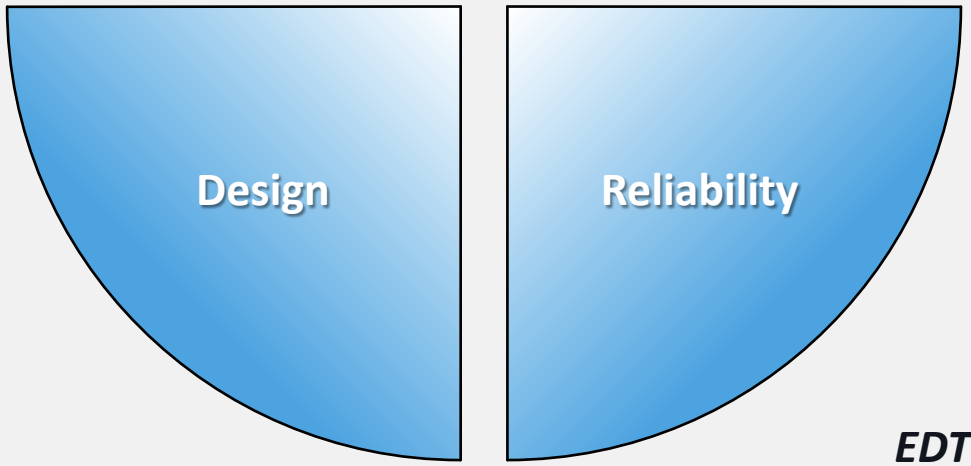
Elements of EDTO assessment



Compliance demonstration:

Responsibility of the Operator

EDTO Operational Approval

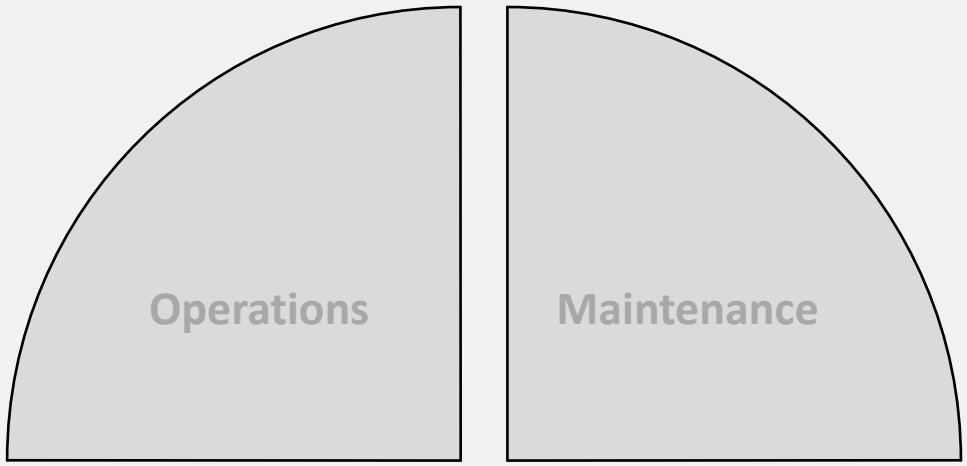


Compliance demonstration:

Responsibility of the Manufacturer

EDTO Type Design & Reliability Approval

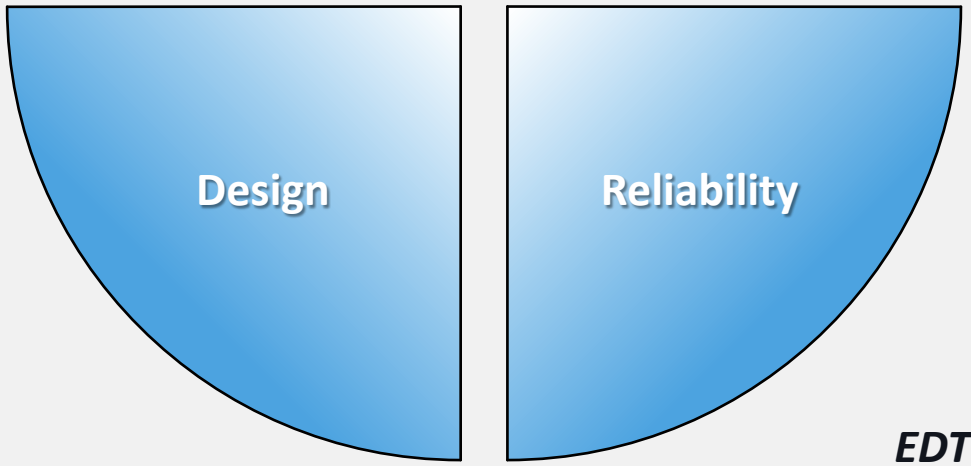
Elements of EDTO assessment



Compliance demonstration:

Responsibility of the Operator

EDTO Operational Approval



Compliance demonstration:

Responsibility of the Manufacturer

EDTO Type Design & Reliability Approval

EDTO Type Design and 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, ...).

Agenda

- 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
  - Continued monitoring of in-service reliability
  - Early EDTO certification
- EDTO aircraft documentation
  - CMP document / AFM / …
- Conclusions

Evolution of EDTO

Type Design Standards

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

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

FAA 207 Policy Letter 20-1

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

- 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

Initial ETOPS Type Design Standard

AC120-42(A)

AC 120-42A (1988)

Extended Range Operations with Two-Engine Airplanes (ETOPS)

Section 1 – Purpose
2 – Cancellations
3 – Related CFRs
4 – Definitions
5 – Discussion
6 – Applicability
7 - Concepts

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

Suitable for the intended extended range operation

Demonstration Flight Test

- 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

- 75-minute operation
- 120-minute operation
- 180-minute operation
- **Draft Appendix 7** Accelerated ETOPS

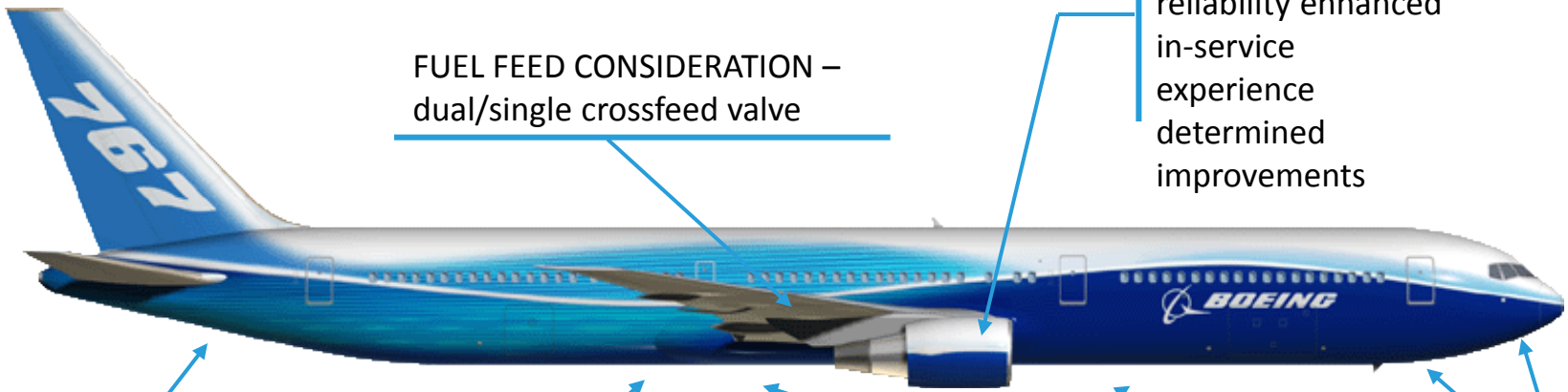
Section 10
Operational Approval
(Also Appendices 3, 4 & 5)

- 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

Section 11
Continuing Surveillance

EDTO Configuration

767*



FUEL FEED CONSIDERATION – dual/single crossfeed valve

Propulsion system reliability enhanced in-service experience determined improvements

APU reliability and start improvements

HYDRAULIC MOTOR GENERATOR (non-time-limited electrical source, which provides power to captain's flight and NAV instruments, etc.)

Additional cargo fire suppression provides 195 min of cargo fire suppression time

Additional equipment cooling monitoring (allows maintenance verification of proper cooling air flow)

First model to qualify for 120 minute (1985) and 180 minute (1989) ETOPS

Initial 777 Early ETOPS
Special Condition

25-ANM-84

777 ETOPS Special Condition 25-ANM-84

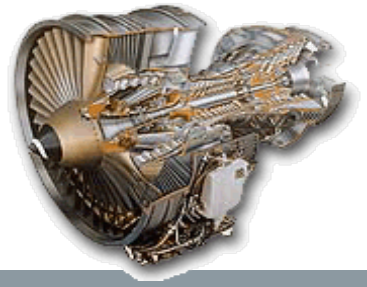
- (a) Introduction
- (b) Engine Assessment
- (c) ETOPS Type Design Assessment
  - (1) Design Requirements Assessment (AC 120-42A)
  - (2) Relevant Experience Assessment
  - (3) Design Features
  - (4) Test Features
  - (5) Analysis Features
  - (6) Manufacturing, Maintenance, or Operational (other) Features
- (d) ETOPS Analyses
- (e) Additional ETOPS Test Requirements
  - (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
- (f) Problem Tracking System
- (g) Reliability Assessment Board (RAB)
- (h) Reliability Demonstration Acceptance Criteria
- (i) Demonstration of Compliance

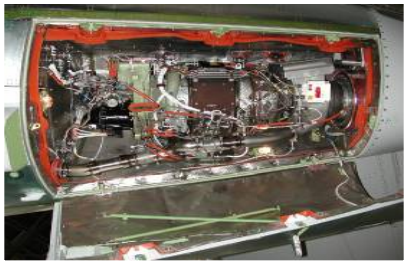
777-300ER Enhanced Special Condition (25-ANM-84A)

Comprehensive ETOPS Type Design Standard

777 ETOPS Special Condition 25-ANM-84A

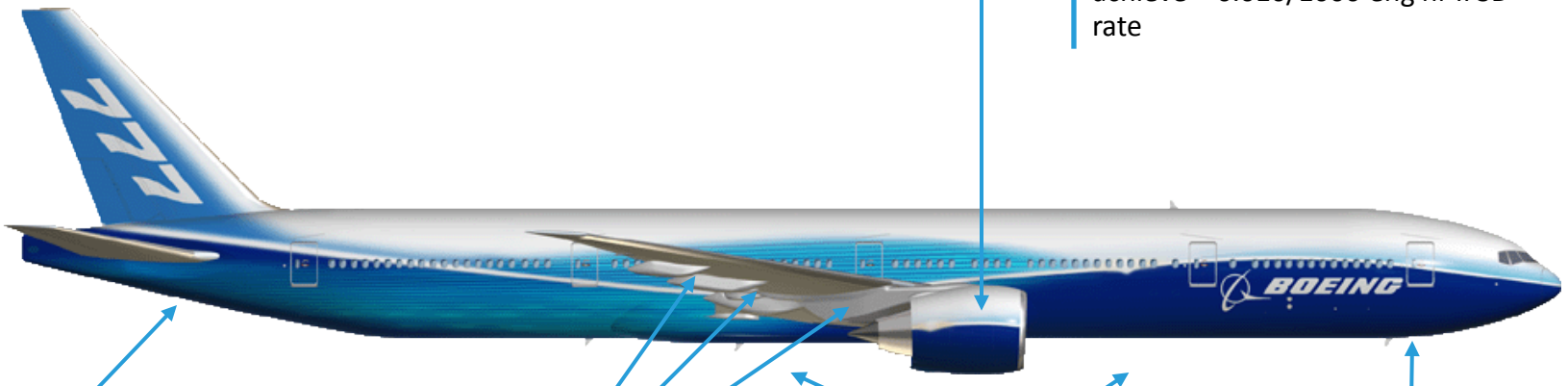
- **(a) Introduction**
- **(b) Engine Assessment**
- **(c) ETOPS Type Design Assessment**
  - (1) Design Requirements Assessment
  - (2) Relevant Experience Assessment
  - (3) Design Features
  - (4) Test Features
  - (5) Analysis Features
  - (6) Manufacturing, Maintenance, or Operational (other) Features
- **(d) ETOPS Analyses**
- **(e) Additional ETOPS Test Requirements**
  - (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 **(Enhanced post-test inspection)**
  - **(7) Airplane ETOPS demonstration test**
- **(f) Problem Tracking System**
- **(g) Reliability Assessment Board (RAB)**
- **(h) Reliability Demonstration Acceptance Criteria**
- **(i) Demonstration of Compliance**





EDTO Configuration

777 *



Backup generators with increased capability

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

APU designed for 99% in-flight start reliability

Dual crossfeed fuel valves

Improved dry bay

Ultrasonic FQIS

195+ minutes of cargo fire suppression time

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

EDTO Configuration

*787**

Variable Frequency Starter Generators (VFSG) with increased capability

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

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 *

Communication (SATCOM capability)

Navigation

Autoland with engine inoperative

Airplane systems designed to support up to 330 minute ETOPS capability

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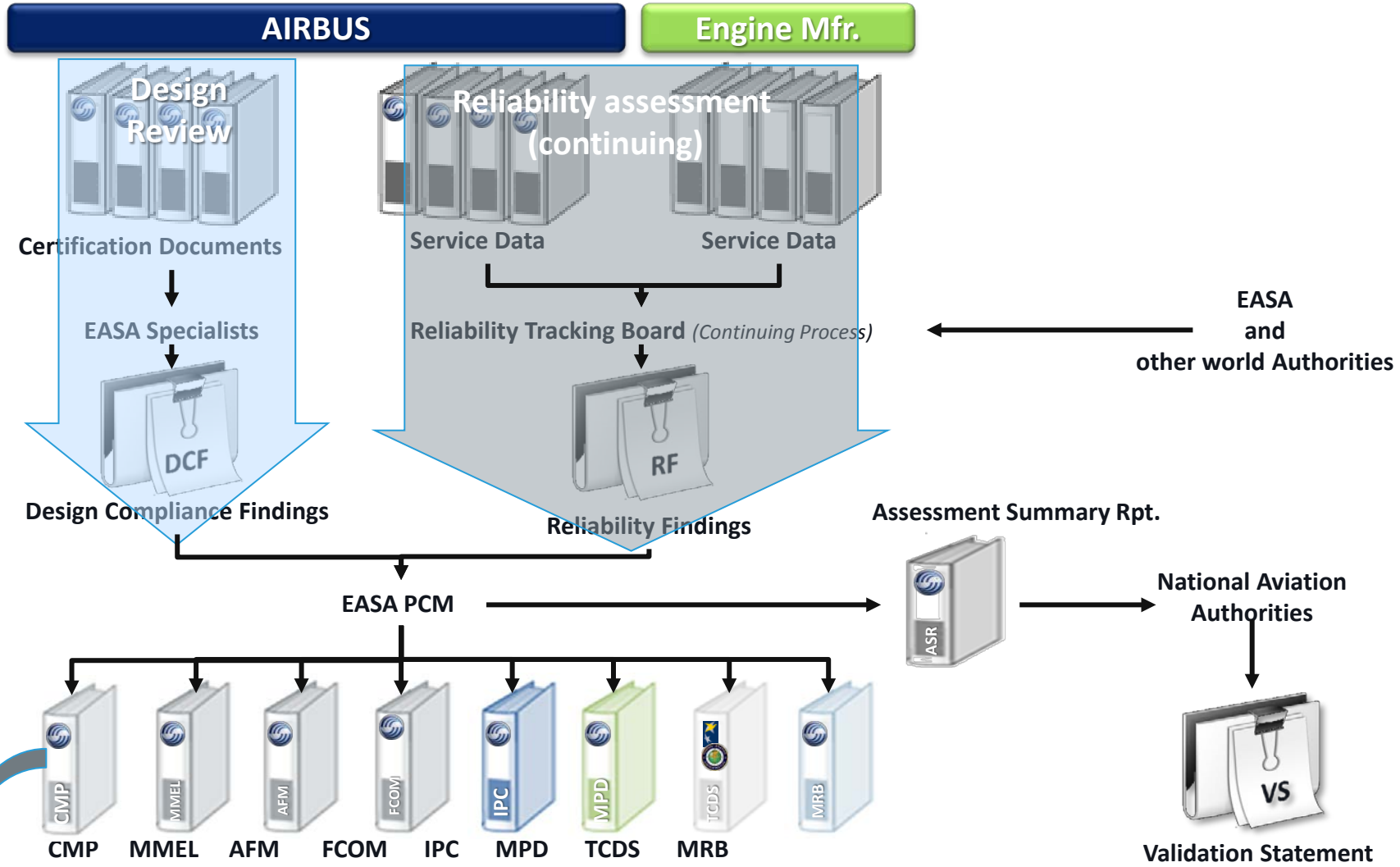
- Conclusions

Type Design & Reliability

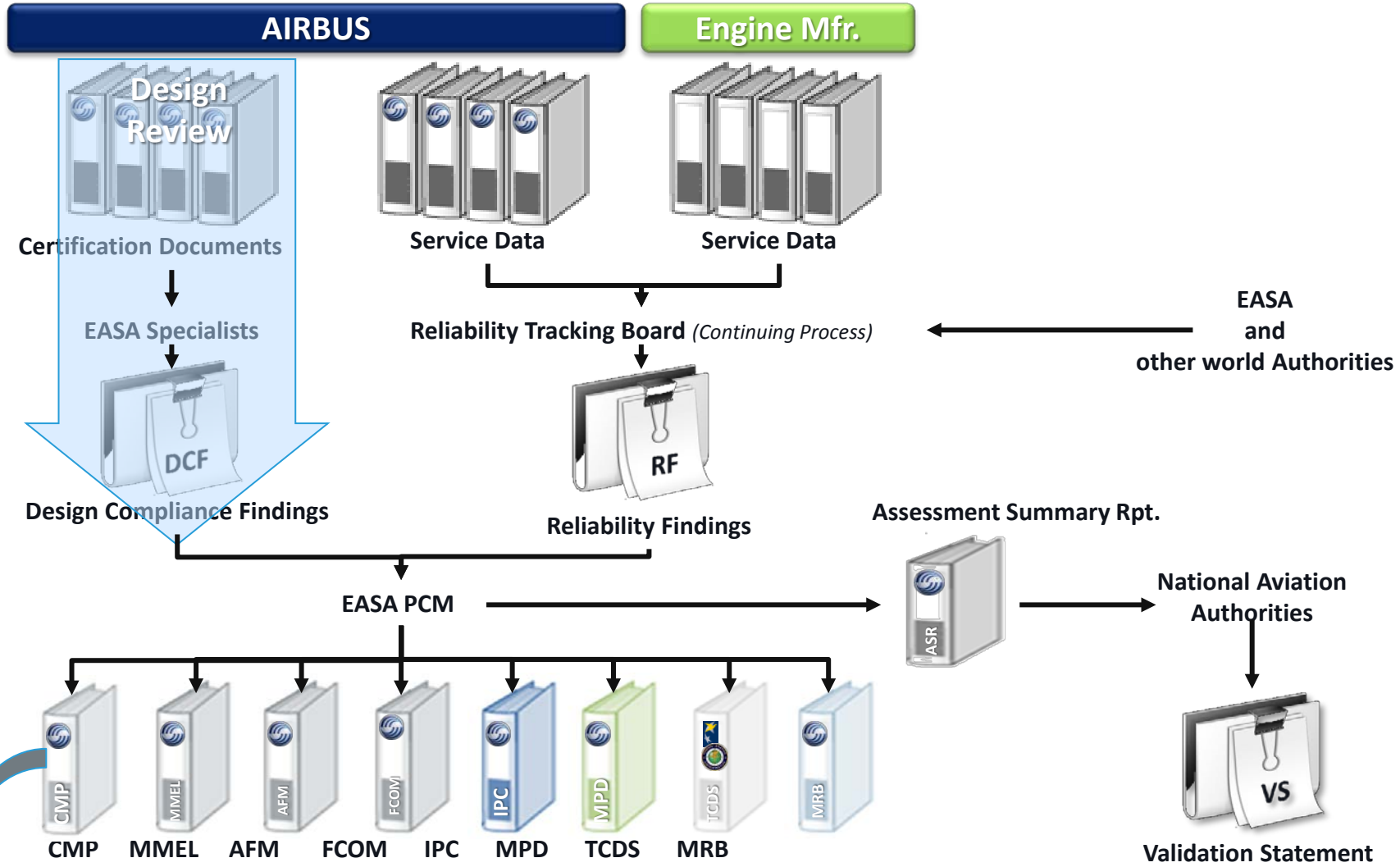
Approval process (EASA)



For EDTO, the A/C must be configured, maintained & operated according to the CMP

Type Design & Reliability

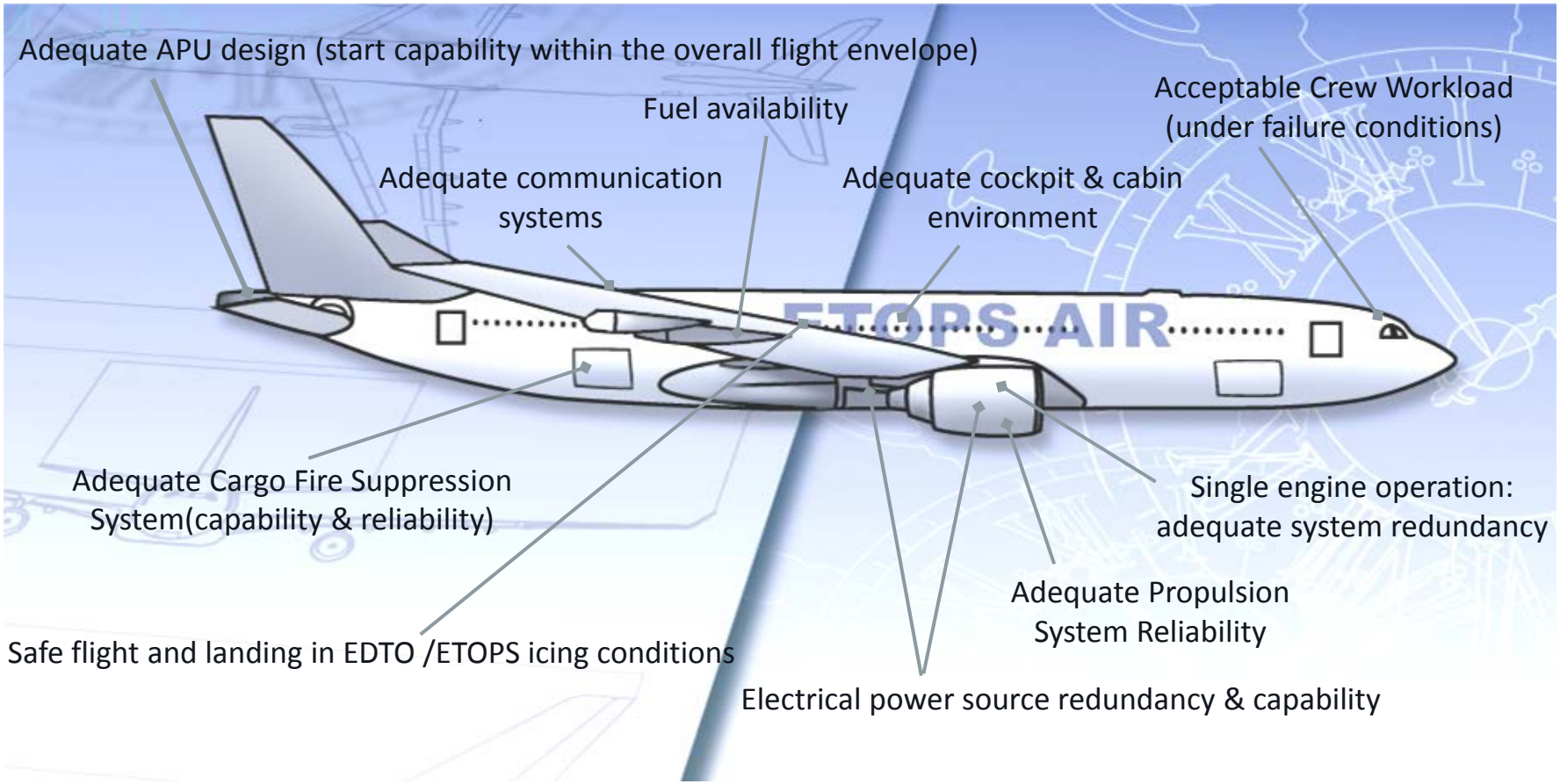
Approval process (EASA)



For EDTO, the A/C must be configured, maintained & operated according to the CMP

EDTO approval of the aircraft
(EDTO/ETOPS certification)

To obtain an EDTO / ETOPS approval of an aircraft, the Manufacturer must show :



Each particular assessment is detailed in the following slides

EDTO approval of the aircraft
(EDTO/ETOPS certification)

* = Analysis considers failure conditions for the maximum diversion time/distance

Human factors and safety analyses

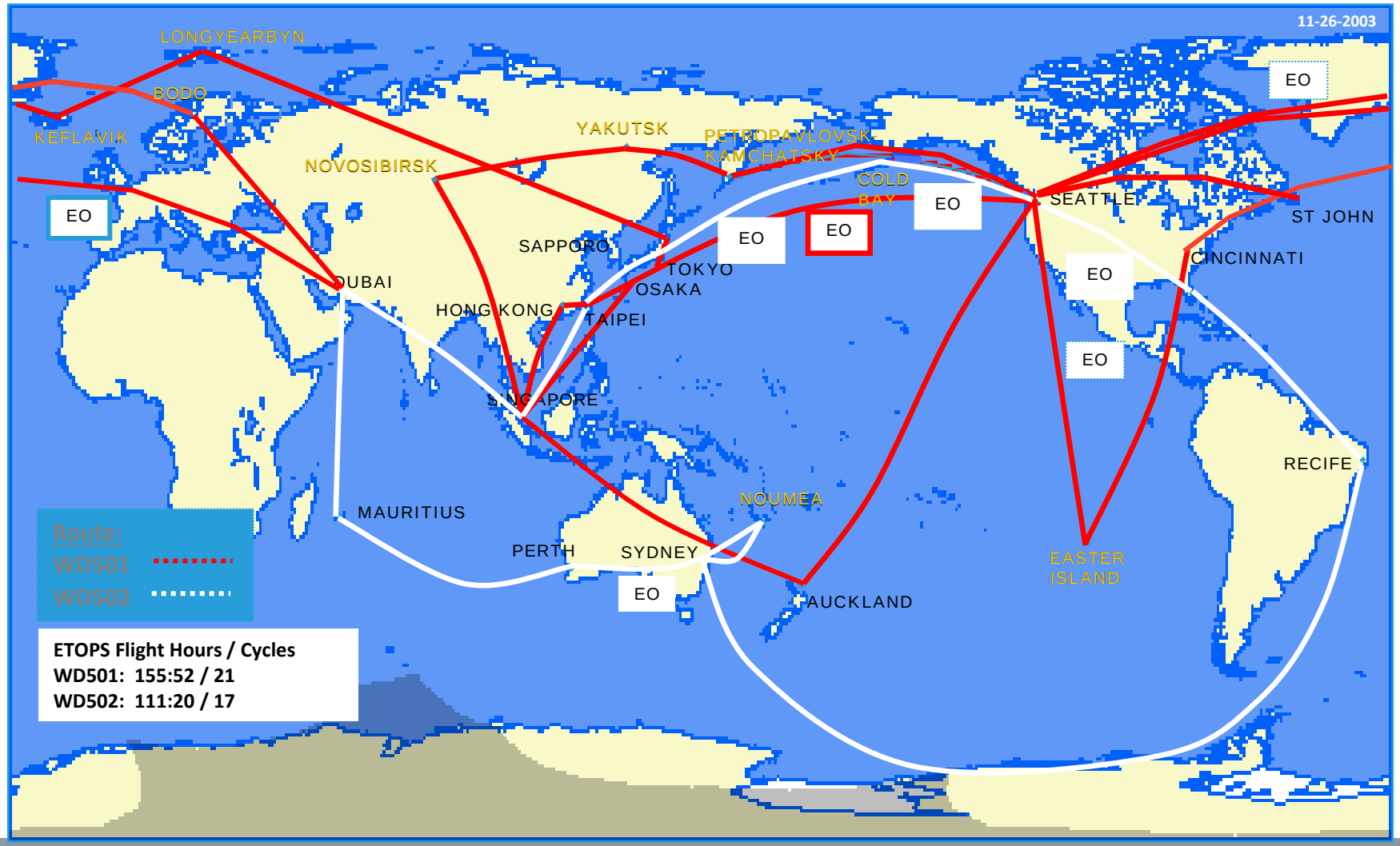
Human Factors

- 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…

Airplane Exposure to ETOPS Operational Environments

(Long flights, diversions with degraded systems, diversions to remote airports)



Human factors and safety analyses

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

Flight Manual
Appendix ETOPS

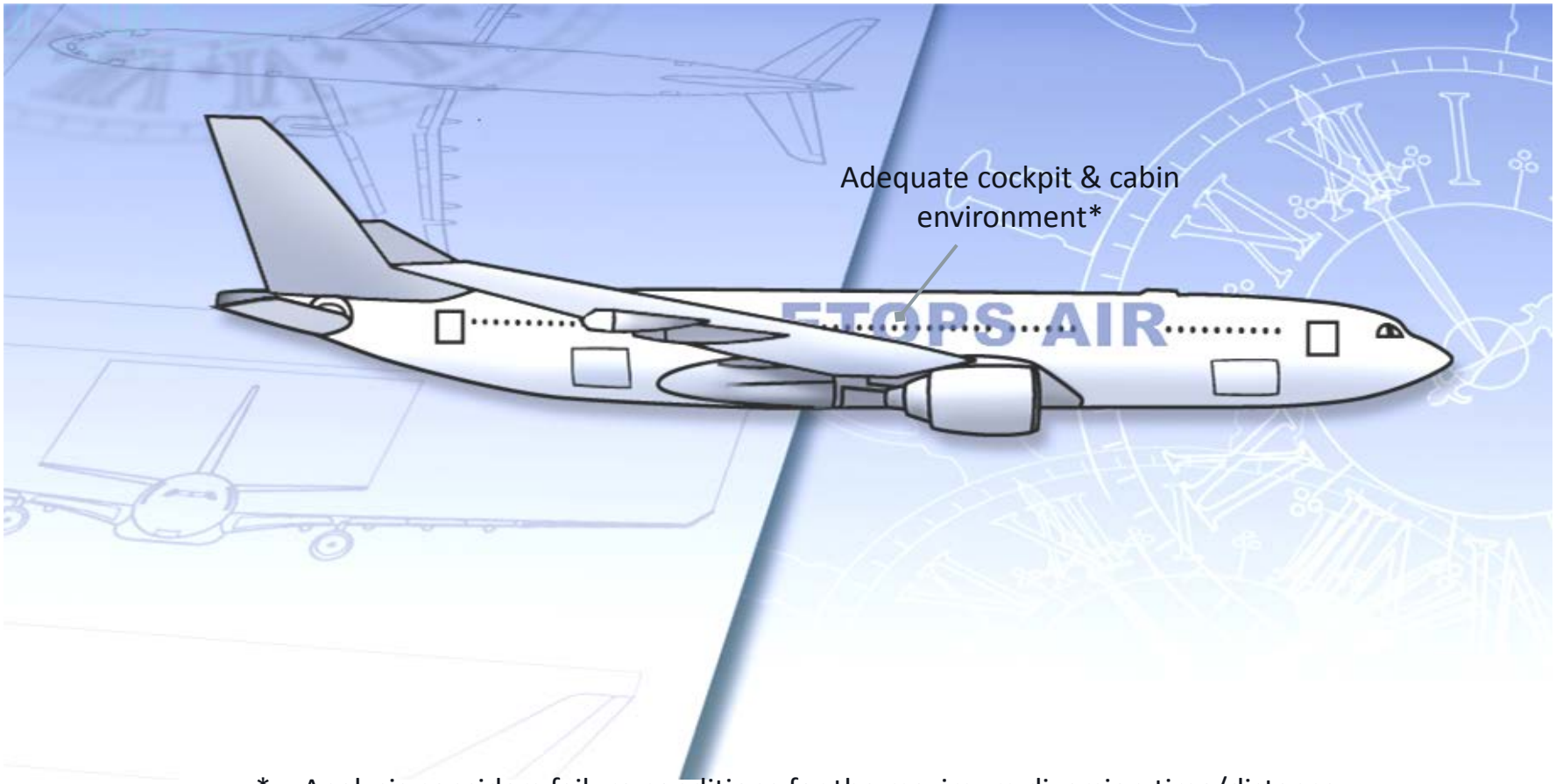
LIMITATIONS

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

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.

Most Time Limited System ≥ EDTO diversion time + 15 min

EDTO approval of the aircraft (EDTO/ETOPS certification)



* = Analysis considers failure conditions for the maximum diversion time/distance

ATA 21 Air Conditioning
Design requirements

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

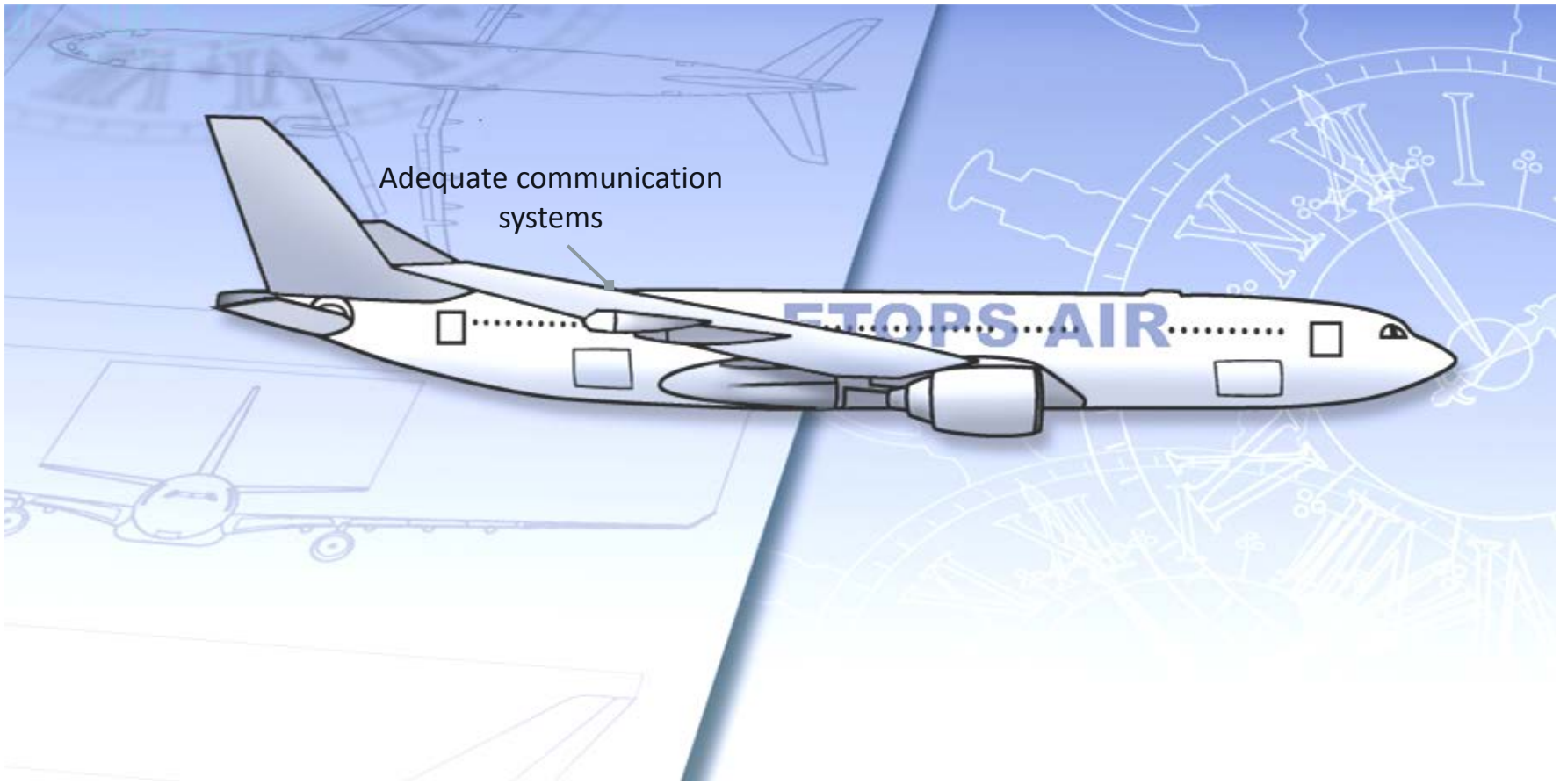
On Airbus aircraft, pressurization and equipment cooling can be ensured with air from :

- One engine air-bleed system only, or
- The APU air-bleed system up to 22,000 ft

WD501 at Svalbard

Longyearbyn (LYR)

EDTO approval of the aircraft
(EDTO/ETOPS certification)



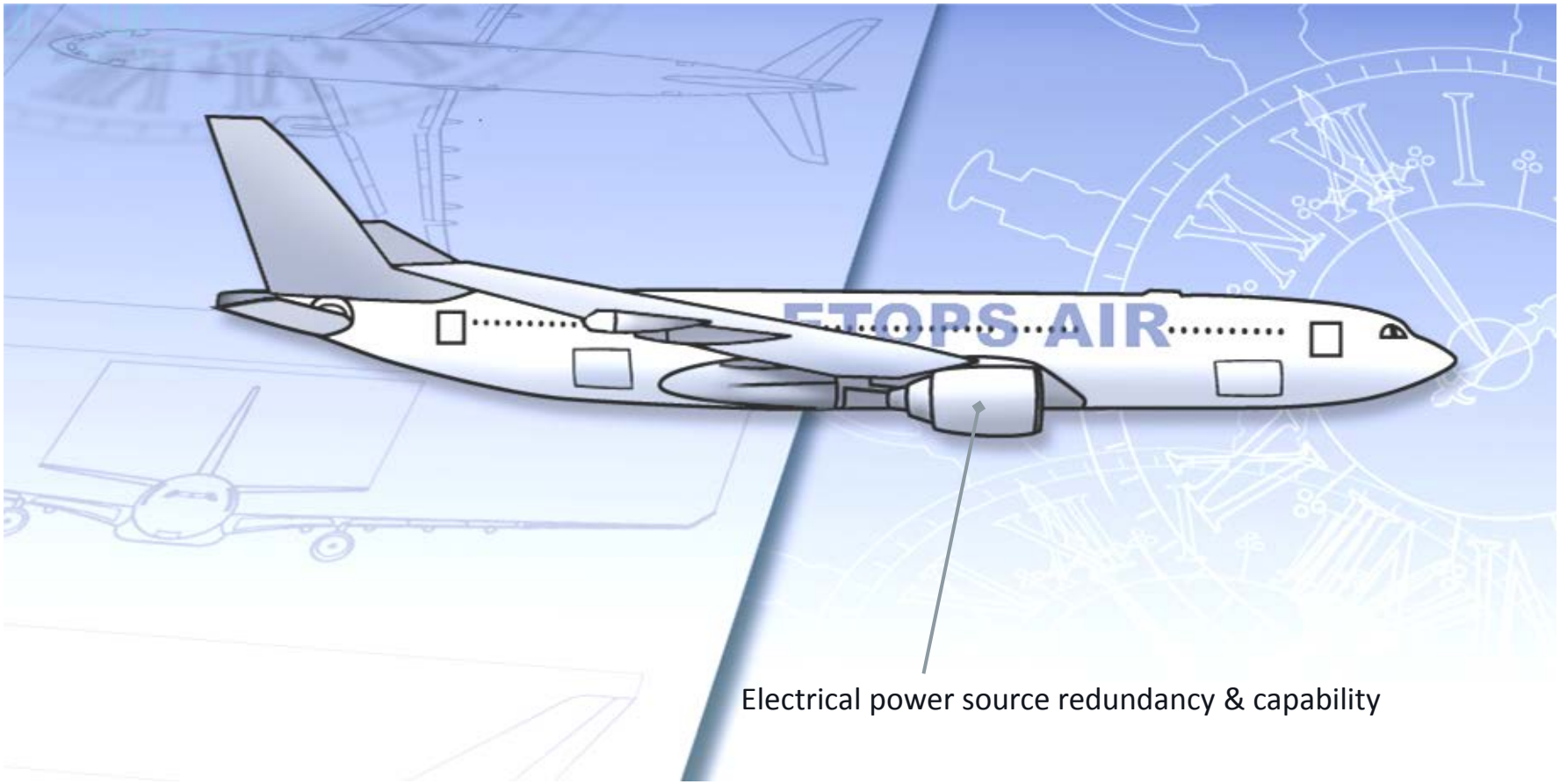
ATA 23 Communication
Design requirements

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)

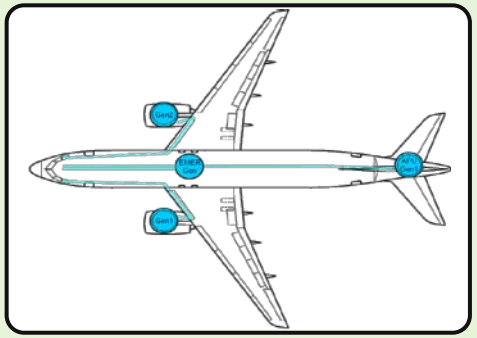


ATA 24 Electrical Generation

Design requirements

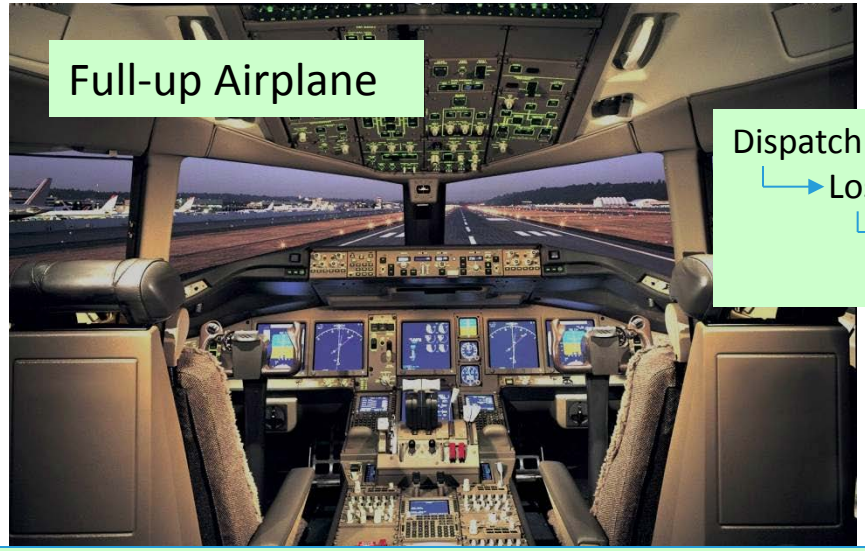
EDTO/ETOPS Design Objectives

- 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

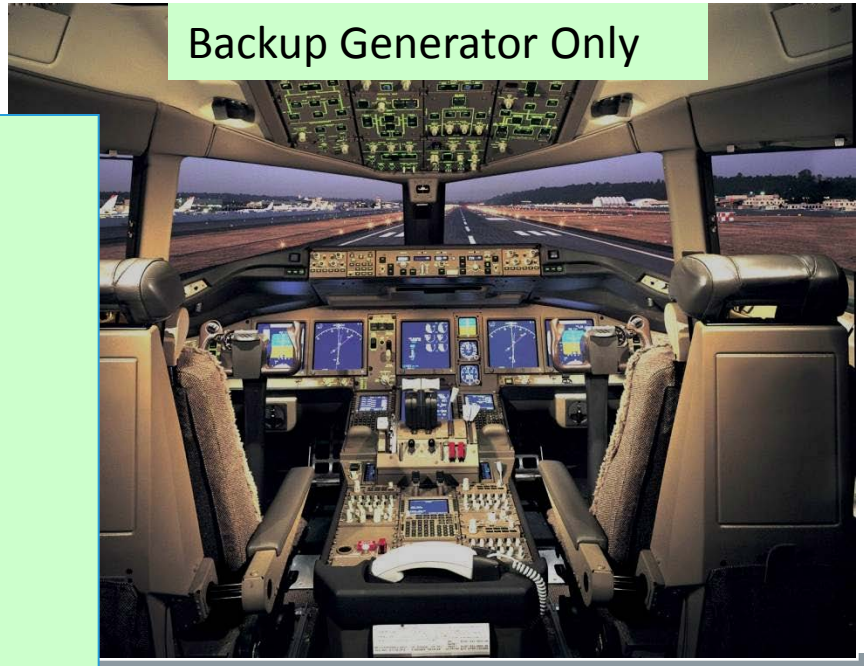


777 Backup Electrical Power

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



ETOPS Essential Loads (abbreviated list)

- Capt. & F/O Flight Instruments
- EICAS
- Communications –VHF L/R/C, HF L, Intercomm
- Navigation – Complete Flight Management, Single Engine Autoland, Weather Radar
- 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

ATA 24 Electrical Generation

Design requirements

Airbus twin engine aircraft (WB, SA and LR) are equipped with :

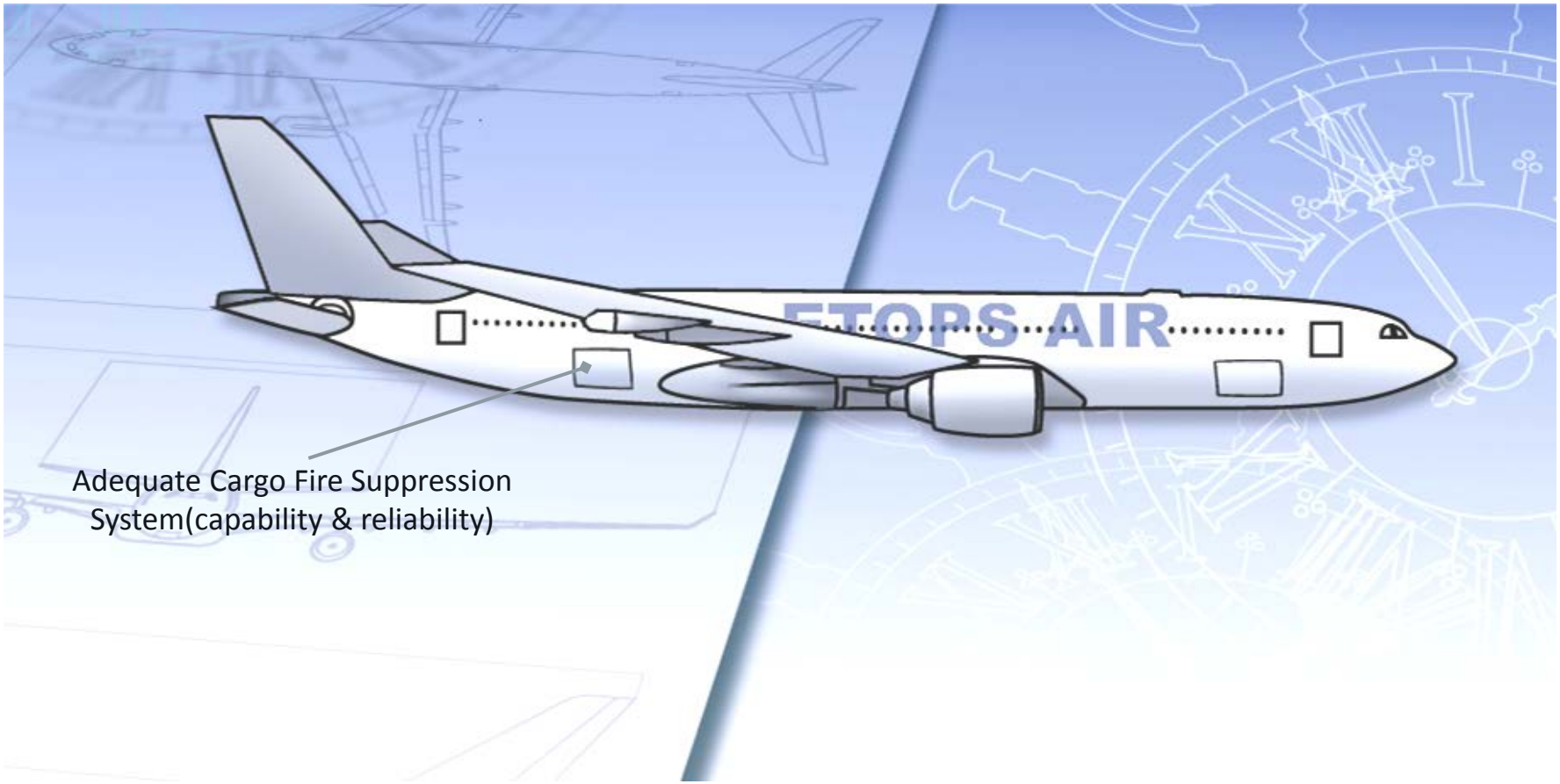
- Two engine driven IDG
- One APU driven APU GEN
- One hydraulically driven Constant Speed Motor / Generator (CSM/G) supplied by the main hydraulic circuit (Green or Blue depending on the aircraft family

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..)

EDTO approval of the aircraft
(EDTO/ETOPS certification)



ATA 26 Fire Protection

Design requirements

Adequate Cargo Fire Suppression System

- 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)

Maximum Diversion Time Must be Within Cargo Fire Suppression System Capability

*All Engine Speed with Prevailing Wind and Temperature for ETOPS Beyond 180/207 Minutes**

Two-engine airplanes

Three- and four-engine airplanes

No change to current operation

- Still air distance
- Standard day
- Length of diversion +15 minutes
- One-engine inoperative speed

180 minute or less area of operation ***(including 207 min)***

No change to current operation

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

Greater than 180-minute area of operation

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

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

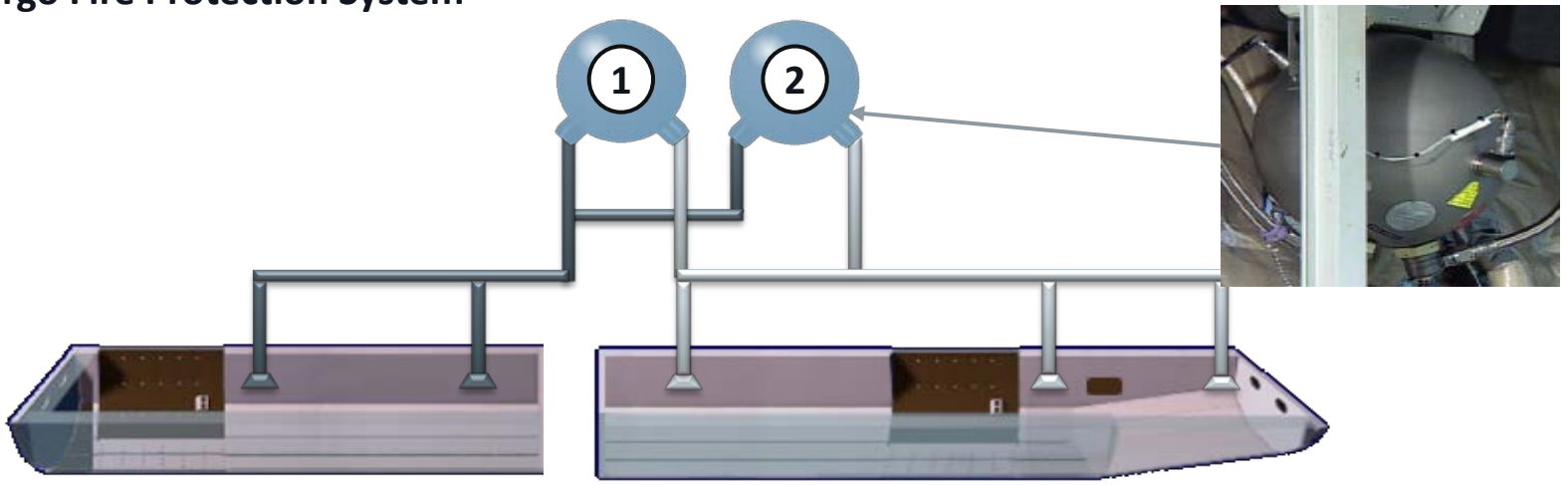
FAR 121.633(b)
EASA AMC 20-6, Chapter III Section 7.2.3 (twins only)

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

ATA 26 Fire Protection

Design requirements

Cargo Fire Protection System



Flight Manual
Appendix ETOPS

LIMITATIONS

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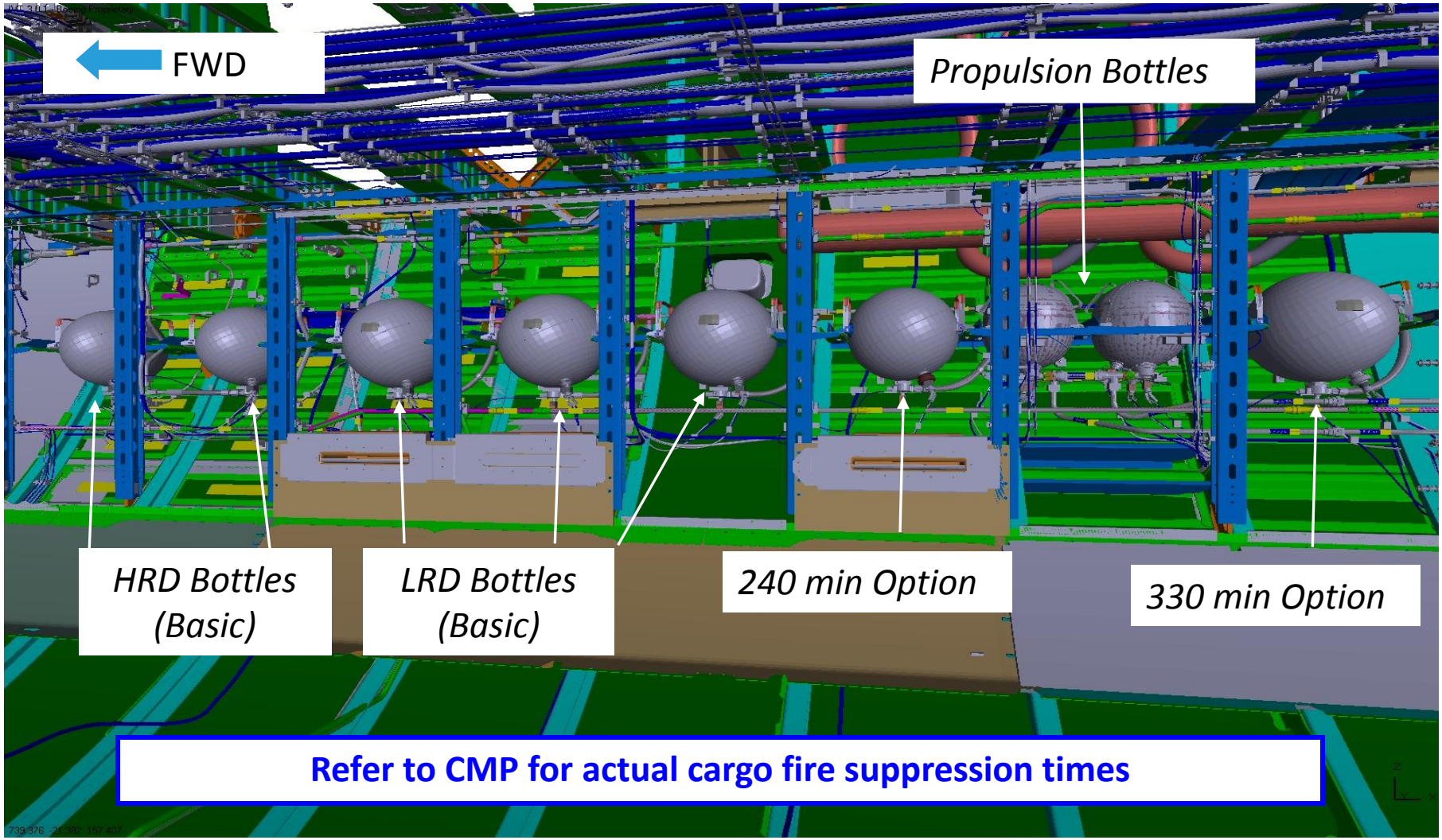
787 EDTO Type Design

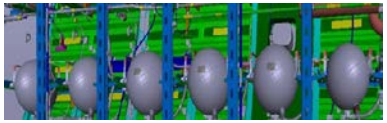
Cargo Fire Suppression Options



Compliance to K25.1.7 - relevant to 121.633 dispatch

787 Cargo Fire Suppression Times

*Diversion planning based on all engine cruise for ETOPS > 180/207 Minutes **



Diversion Time per Fire Extinquisher Bottle

Fire Extinguisher Bottle	Diversion Time Capability per Bottle (Minutes)
2A	60
2B	60
2C	60
2D	47
2E	64

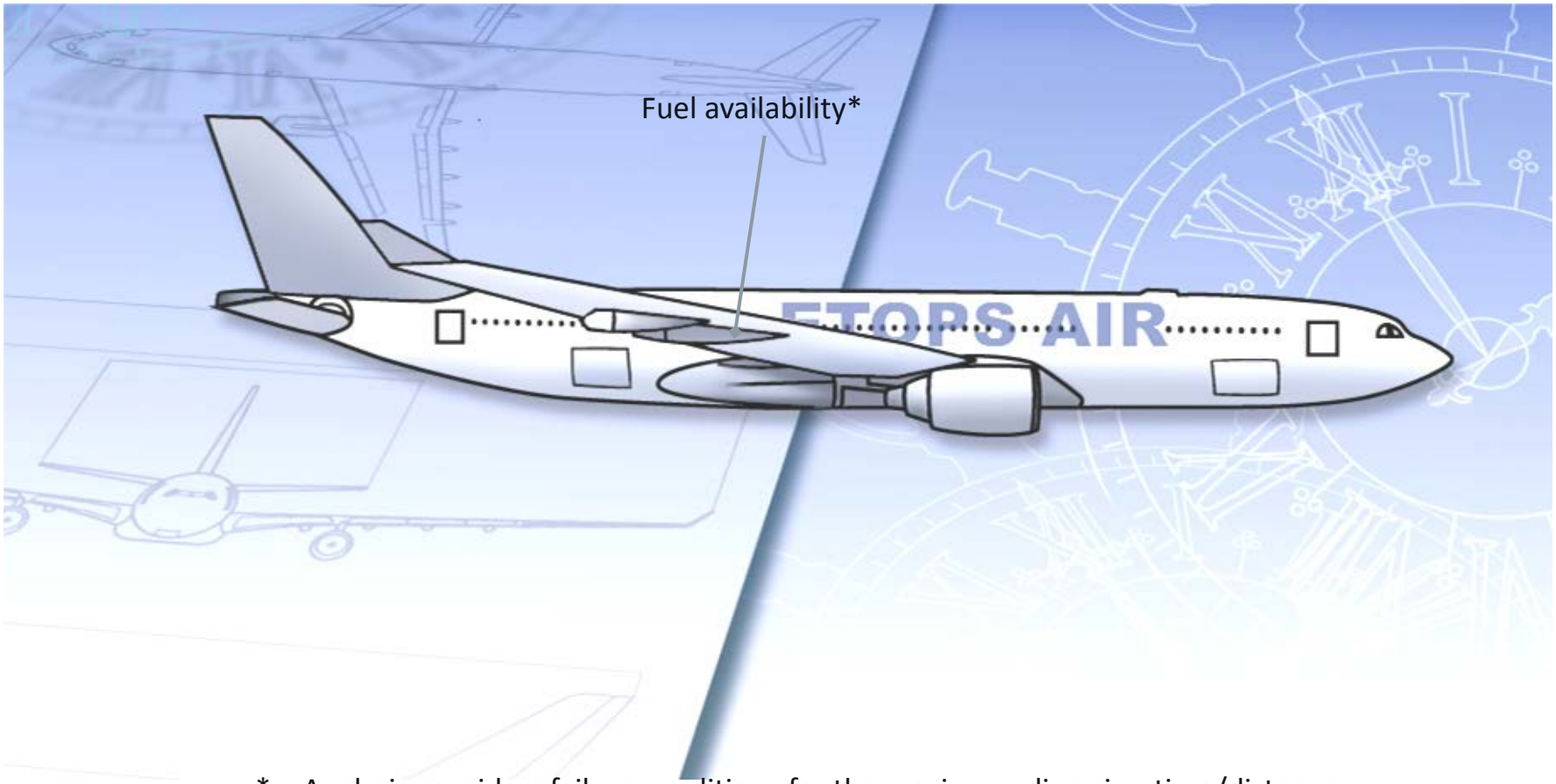
High rate discharge bottles 1A and 1B provide initial 15 minutes of suppression time.

Bottle Configuration	Suppression Time	ETOPS Capability
2A, 2B, 2C	195 minutes	Up to 180 minutes
2A, 2B, 2C, 2D	242 minutes	207 minutes
2A, 2B, 2C, 2D	242 minutes	240 minutes
2A, 2B, 2C, 2D, 2E	306 minutes	Up to 330 minutes

** 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

ATA 28 Fuel

Design requirements

EDTO/ETOPS Design Objectives

- 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:

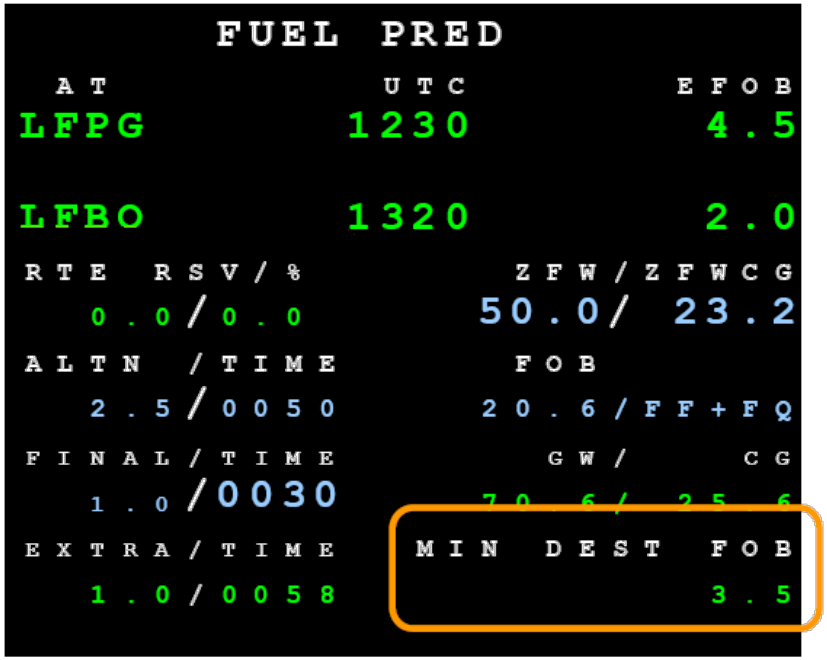
EXTRA = DEST EFOB – (ALTN + FINAL)

MIN DEST FOB

If DEST EFOB becomes lower than MIN DEST FOB :

FUEL ALERT

- DEST EFOB turns amber on MCDU pages
- **DEST EFOB BELOW MIN** message (except in T/O or CLB)



EDTO approval of the aircraft
(EDTO/ETOPS certification)

System Redundancy
Design requirements

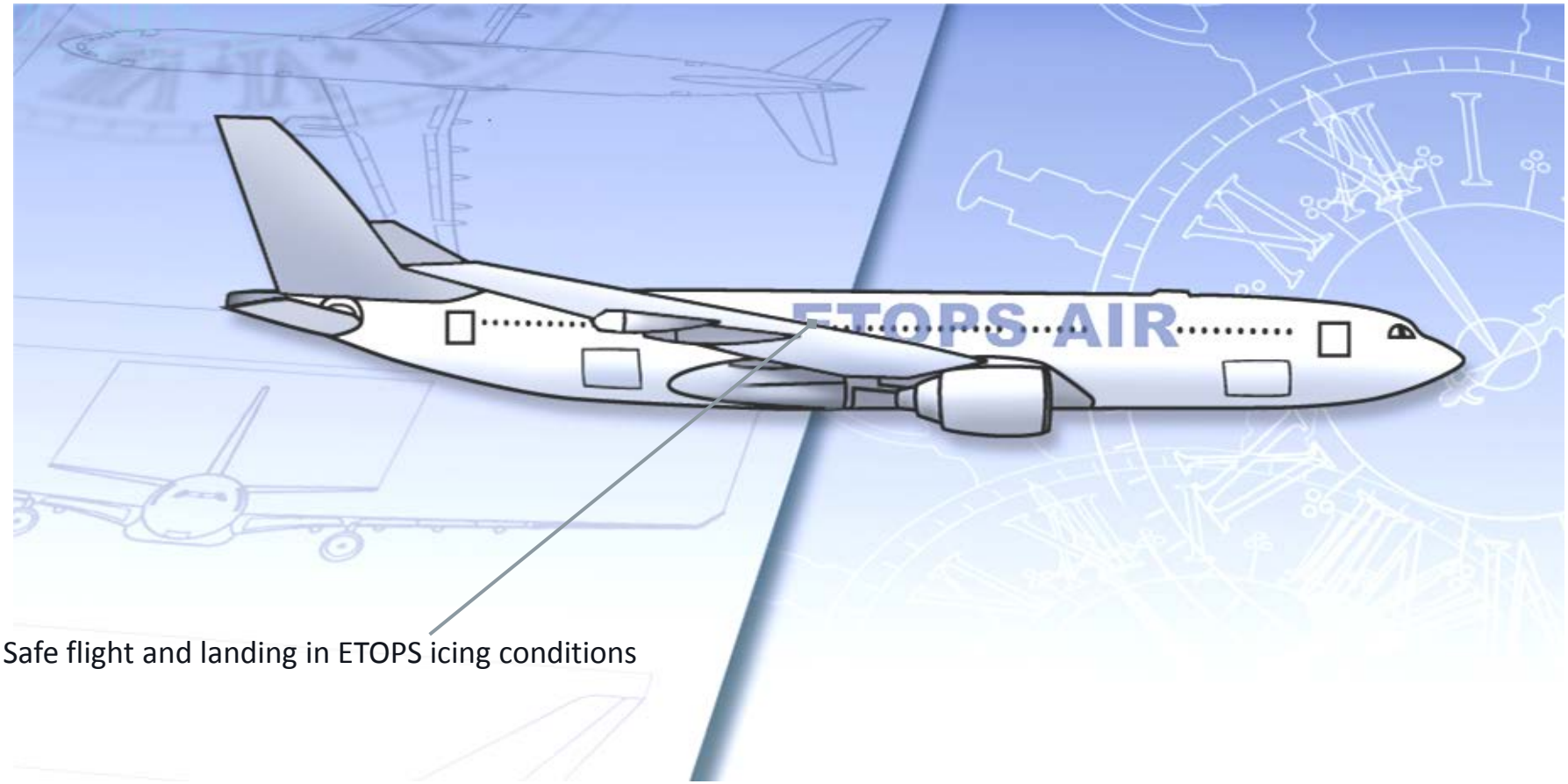
Adequate System Redundancy

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:

Systems	Normal	One engine shutdown
Hydraulic	3 systems 1 RAT backup	2 systems 1 RAT backup
Electrical	4 generators - 2 engines - 1 APU - 1 Emergency Gen	3 generators - 1 engine - 1 APU - 1 Emergency Gen
Pneumatic	3 air bleed sources - 2 engines - 1 APU	2 air bleed sources - 1 engine - 1 APU

EDTO approval of the aircraft
(EDTO/ETOPS certification)



Safe flight and landing in ETOPS icing conditions

ATA 30 Ice and Rain Protection

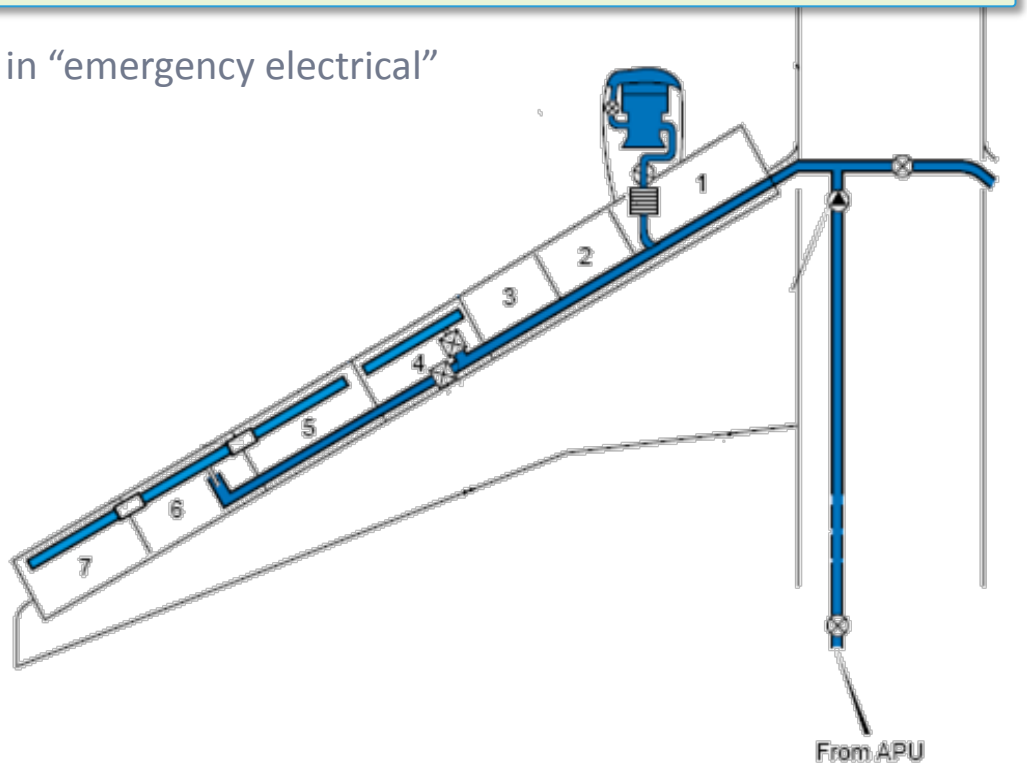
Design requirements

Adequate Ice Protection

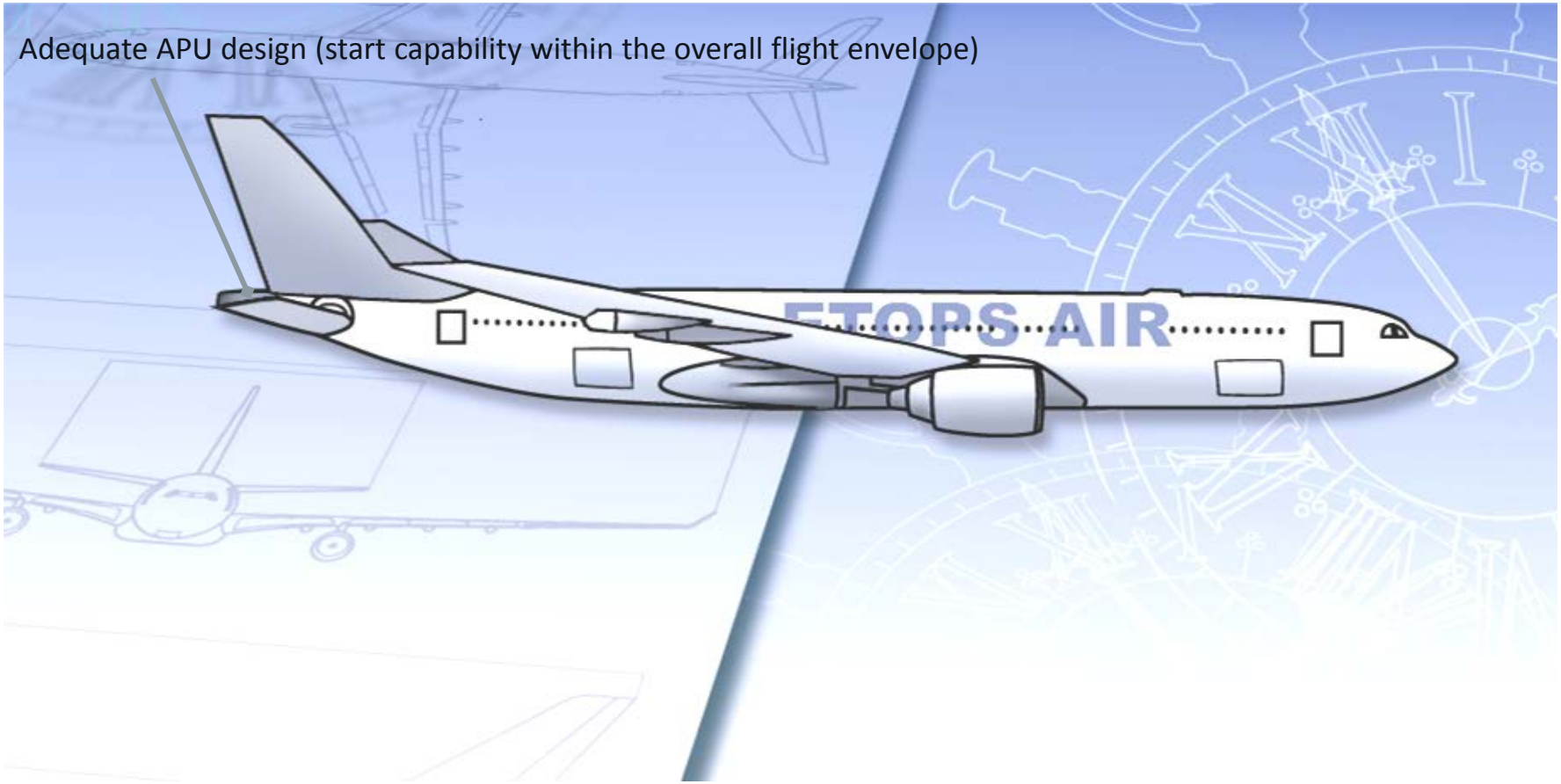
Performance and handling effects of ice accretion on unprotected surfaces must be accounted for.

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



EDTO approval of the aircraft
(EDTO/ETOPS certification)



ETOPS Design Objectives

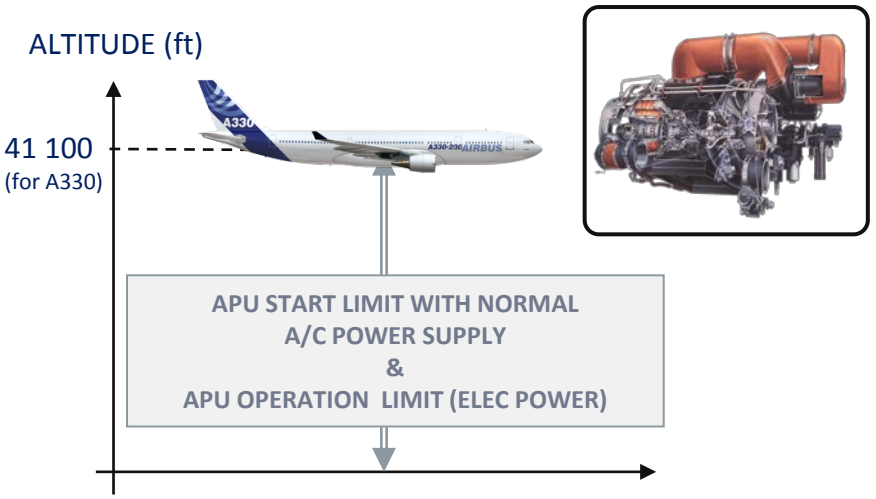
APU installation should meet normal certification requirements

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

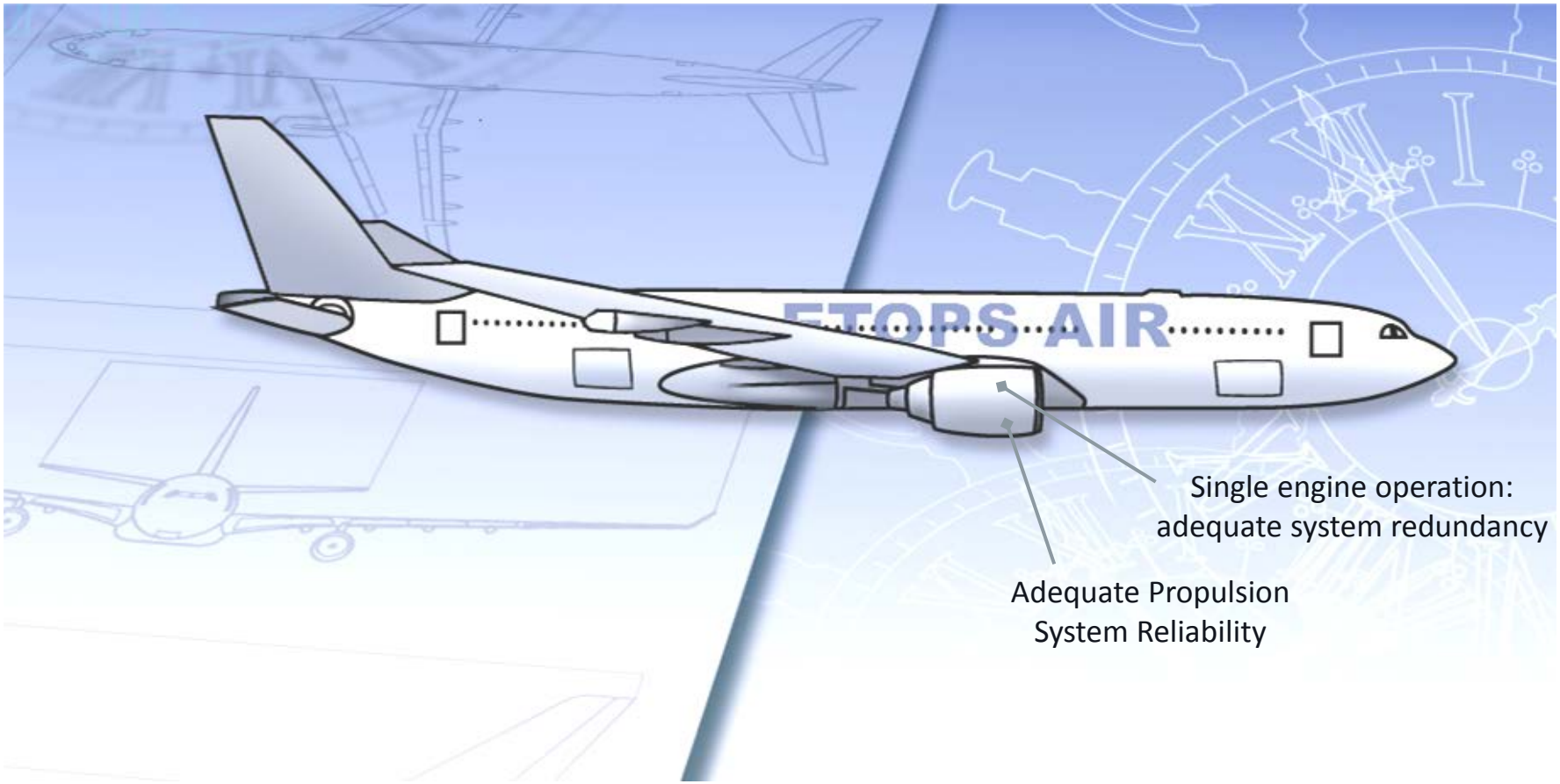
- Demonstrated in-flight start capability: 95%
- Demonstrated run reliability: 10 E-3 / APU operating hour failure rate (MTBF >1000 hrs)
- Compliance with above reliability objectives must be demonstrated through in service experience and Early EDTO/ETOPS demonstration in case of EDTO at EIS

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)



ATA 71-80 Powerplant

Design requirements

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 Shut Down
Rate Monitoring - Definition

AMC 20 - 6 Rev 2
16/12/2010

EUROPEAN AVIATION SAFETY AGENCY
AGENCE EUROPEENNE DE LA SECURITE AERIENNE
EUROPAISCHE AGENTUR FUR FLUGSICHERHEIT

Extended Range Operation with Two-Engine Aeroplanes
ETOPS Certification & Operation

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.

AC 120 - 42B

This definition is fully harmonized with FAA definition (AC 120-42B)

- Similar definition to AMC 20-6 Rev 2

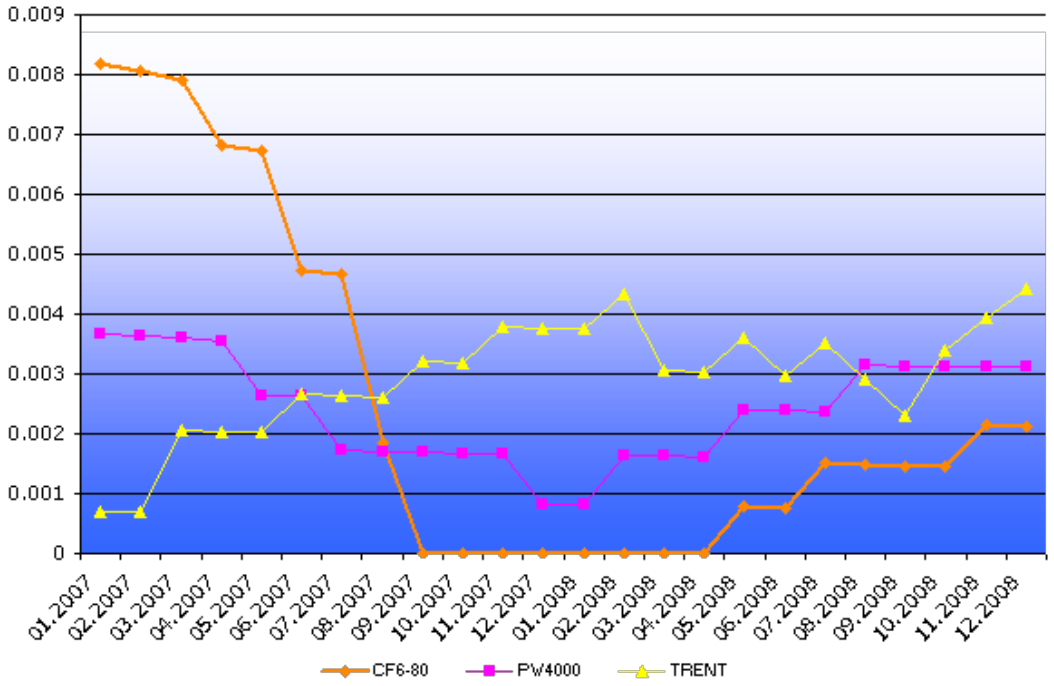
These events as well as engine failures occurring before take-off decision speed or after touch-down, although not counted as IFSD, are reviewed & reported in the frame of continued airworthiness for ETOPS.

In-Flight Shut Down
Rate Monitoring

EDTO/ETOPS Type Design approval requirements for IFSD (Twins):

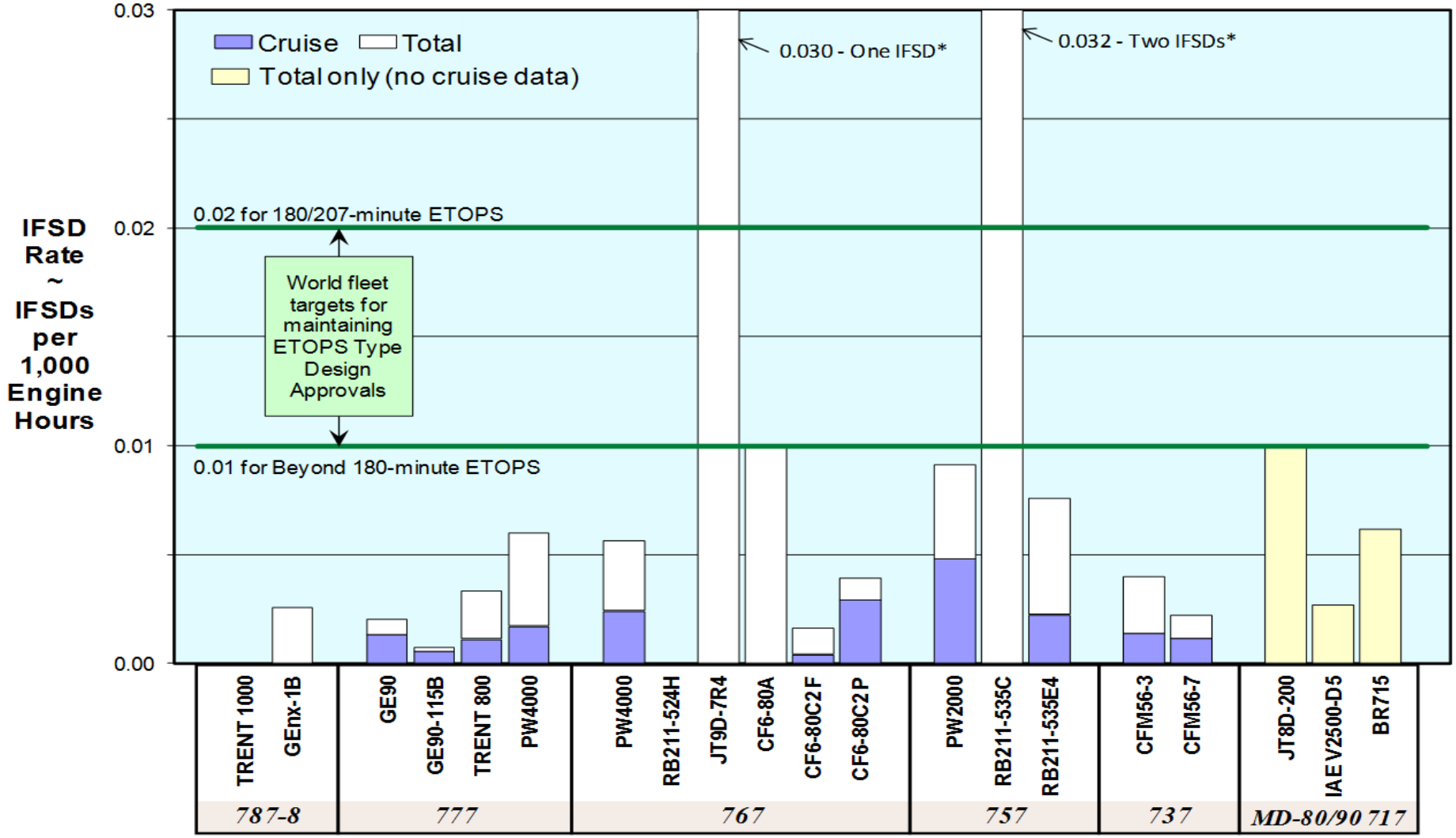
- EDTO 120 min: 0.050/1000 EH
- EDTO 180 min: 0.020/1000 EH
- EDTO beyond 180 min: 0.010/1000 EH

Based on world fleet 12 month rolling average



World Fleet IFSD
Rates of Boeing Twins

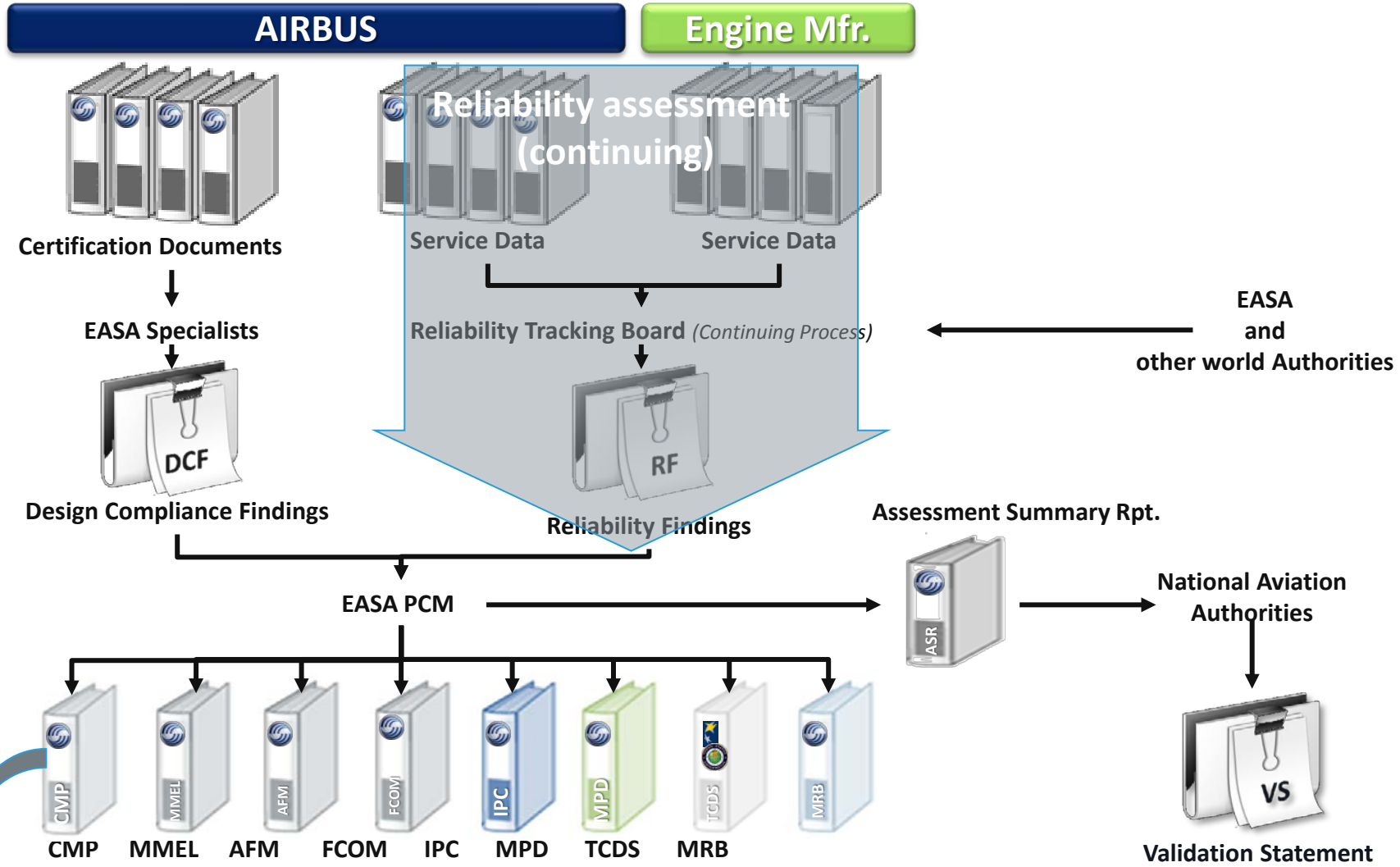
12-Month Average as of March, 2014



* High IFSD rate is insignificant - due to only one or two IFSDs in the period and few flight hours.

Type Design & Reliability

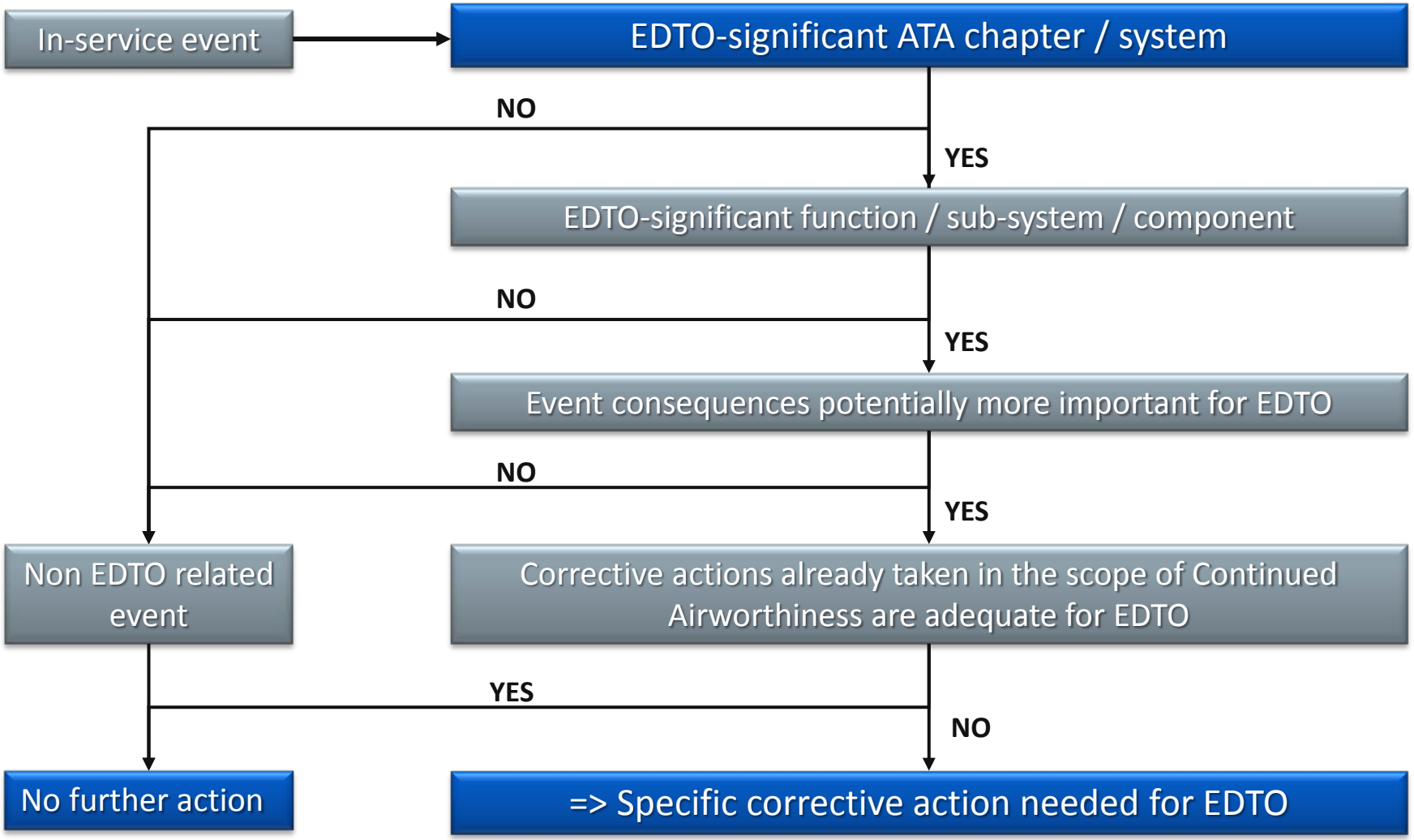
Approval process (EASA)



For EDTO, the A/C must be configured, maintained & operated according to the CMP

EDTO Reliability Monitoring

In-service event review



Early EDTO approval

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

Early-EDTO Type Design
Certification Process

ETOPS Philosophy

Preclude and Protect Diversions

Early-ETOPS Type Design Certification Process

EASA AMC 20-6 Ch II – Section 6.2	FAR Part 25.1535 & App. K

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

787 EDTO Type Design

Propulsion System 3000 Cycle Ground Tests

- 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 EDTO Design Approval

787 APU ETOPS Design Approval

Hamilton Sundstrand
A United Technologies Company

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

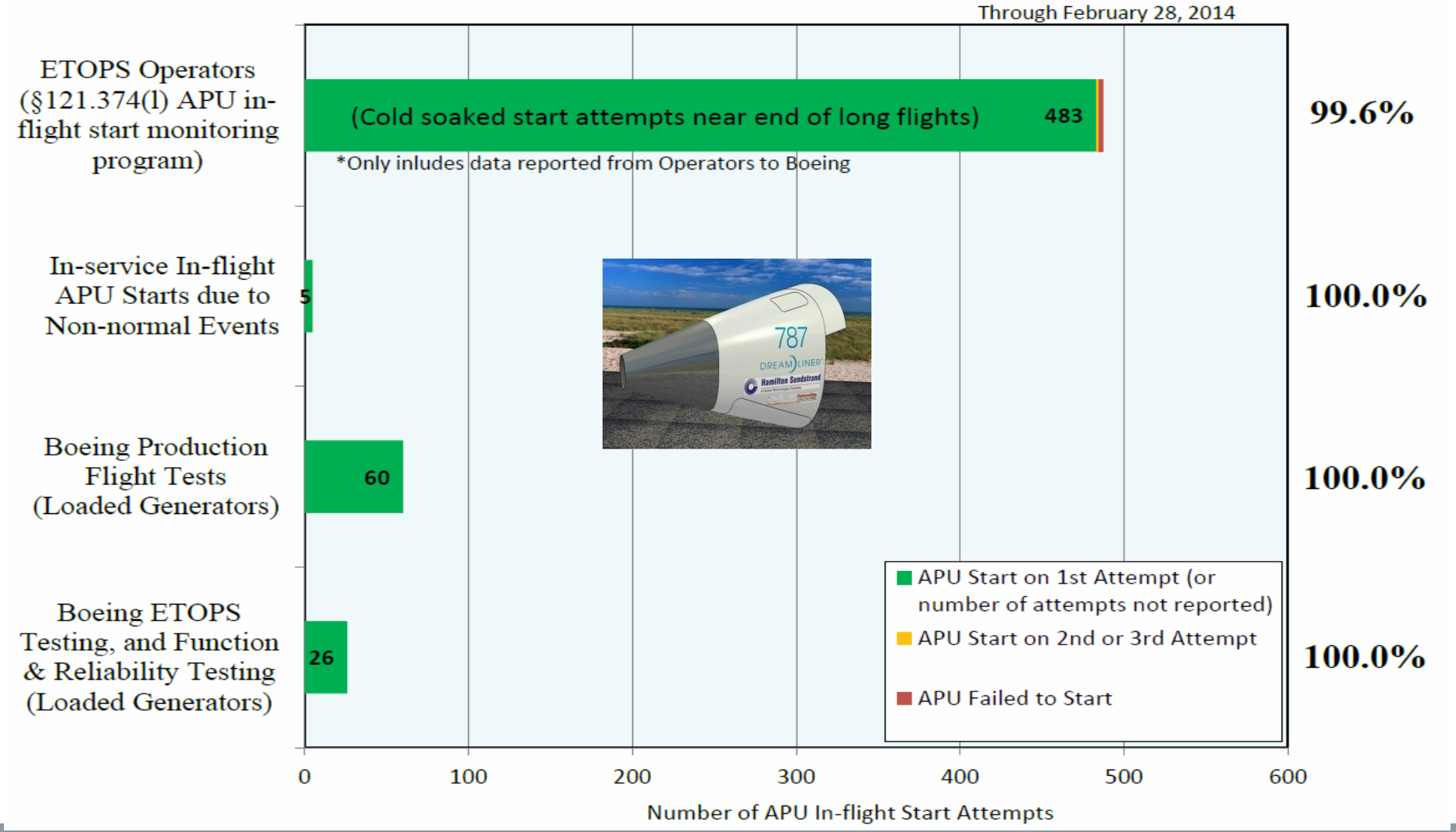
APU maintenance task validations

- 3 airlines, 122 tasks validated

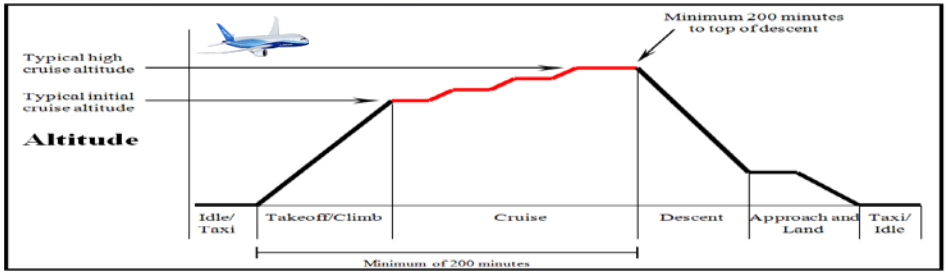
Compliance to K25.2.2(c) and (f)

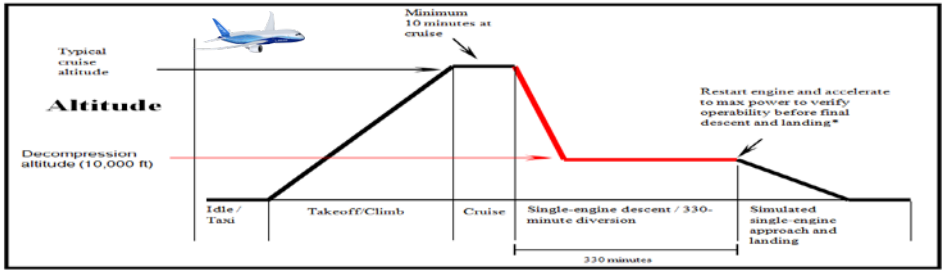
787 APU In-flight Start Performance

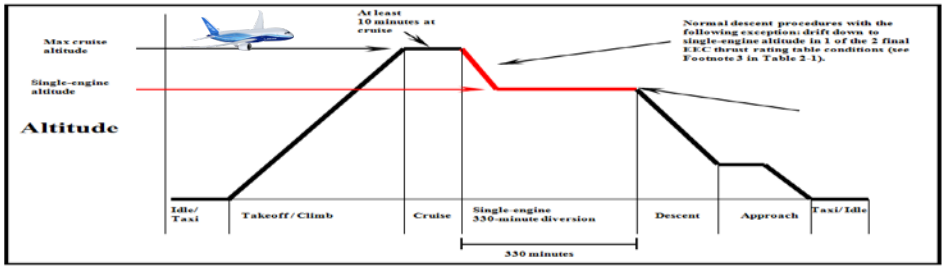
Initial Operator Service Experience and Boeing Flight Test

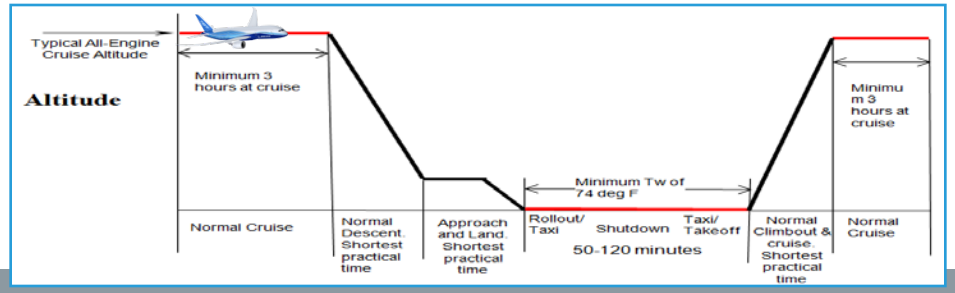


787 EDTO
Demonstration Flight Tests









- 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)

787-8 EDTO
Demonstration Flight Tests

*Flight Test Scenarios and Statistics Summary**

Compliance to K25.2.2(g)

Scenarios/Other	Trent 1000	Trent 1000 Package B	GEnx	GEnx PIP I	Totals
Airplanes	1	1	2	1	5
Flights	29	2	31	2	64
Flight hours	217	14	204	13	448*
Humidity cycles	10	–	10	–	20
Engine-out conditions (345 minutes)	8	2	13	2	25
Degraded electrical (345 minutes)	6	–	8	–	14
Single VFSG	1	–	2	–	3
APU only	1	–	–	–	1
Degraded ECS/PECS (345 minutes)	6	–	–	–	6
Max ETOPS mission	18:24	–	19:12	–	–
Diversion airports	3	–	–	–	3
Post-test inspections	Yes	Yes	Yes	Yes	–

* 6,775 total 787-8 flight test hours thru November, 2012

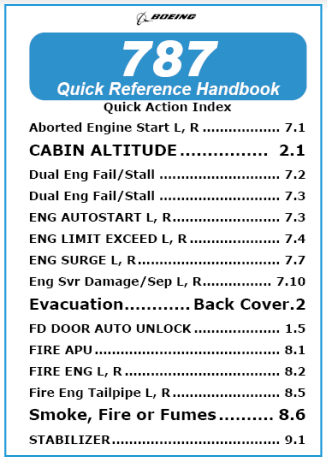
787 ETOPS Type Design

Maintenance & Operational Task Validations

- 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)

787 ETOPS Type Design
Operational Procedure Validations


BOEING
787
Quick Reference Handbook
Quick Action Index

All 787 Flight Operations Procedures

Normal Non-normal Supplementary DDG

Affects ETOPS Significant Systems?

yes

Validate Procedure
- Analysis
- Engineering Cab
- Flight Test

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)

Agenda

- 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 aircraft documentation

EDTO/ETOPS CMP Document

EDTO/ETOPS CMP Document

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)**

CMP Document

For EDTO, the aircraft must be configured, maintained and operated according to the CMP Document

EDTO aircraft documentation

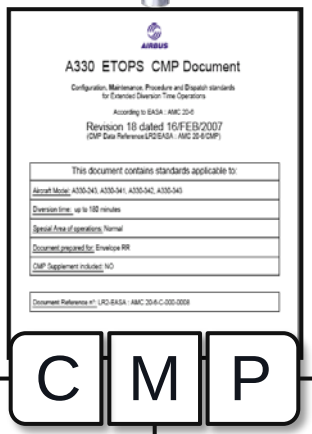
EDTO/ETOPS CMP Document

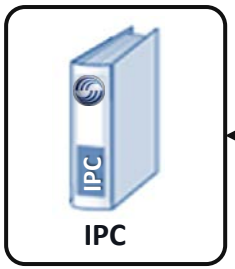
For Entry into Service:

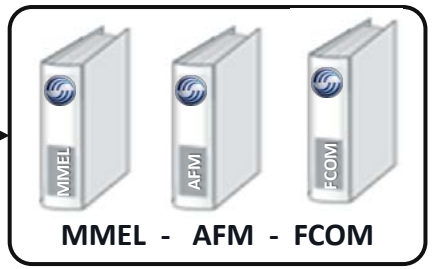
- Flight Test Results
- Simulation
- Syst. Safety Assmt.
- A/C Related Events

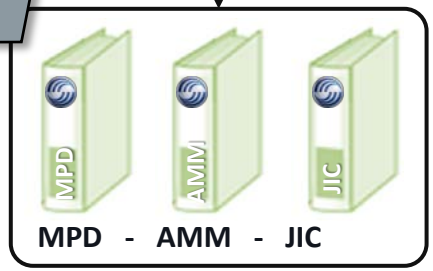
For Aircraft in-service:

- Reliability trends
- Events
- Modifications
- Other A/C Rel.events









ETOPS Maintenance Practices
ETOPS Critical / Significant Items

EDTO aircraft documentation

EDTO/ETOPS CMP Document revision policy - EASA / FAA

EUROPEAN AVIATION SAFETY AGENCY

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.

Federal Aviation Administration

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)

EDTO aircraft documentation

CMP Document – Airbus Table of approved models

AIRBUS

Approved Aircraft Model / Engine combinations

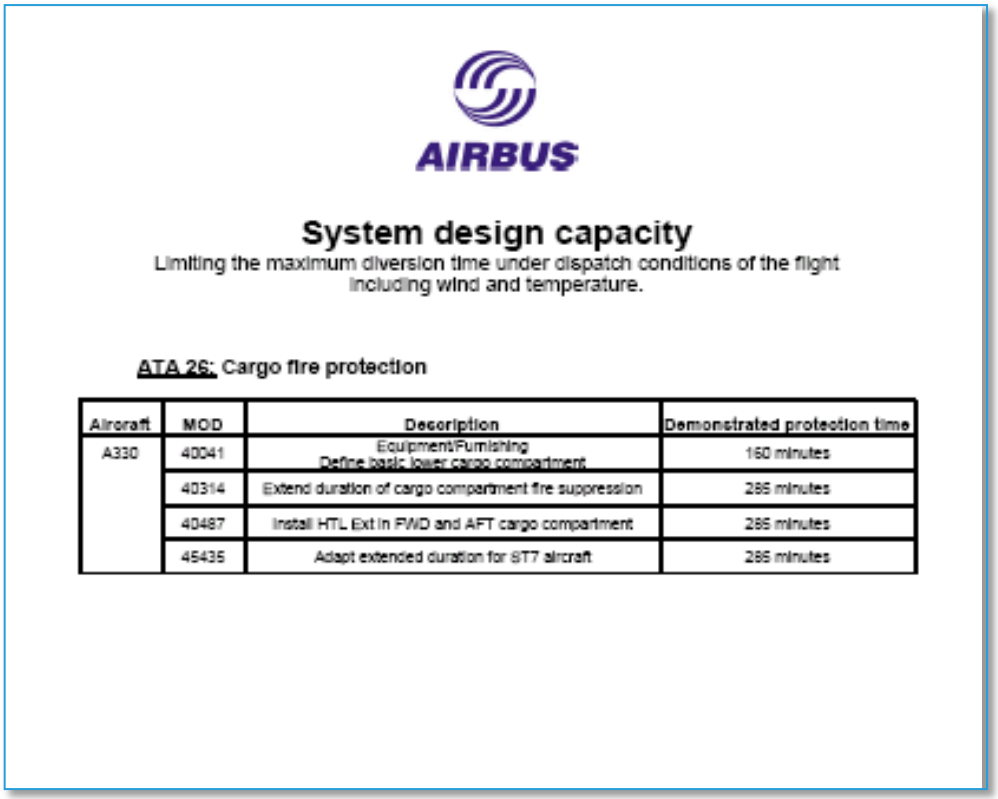
Aircraft Model	Engine	Basic or Intermix	Maximum diversion time (Minutes)	Areas of operation
A330-201	CF6-80E1A2	Basic	180	Normal
A330-202	CF6-80E1A4	Basic	180	Normal
A330-202	CF6-80E1A2	Intermix	180	Normal
A330-203	CF6-80E1A3	Basic	180	Normal
A330-223	PW4168A	Basic	180	Normal
A330-243	TRENT772B-60	Basic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

Approved Airplane / Engine combinations

Maximum authorized Diversion Time

EDTO aircraft documentation

CMP Document – Airbus Time Limited Systems



AIRBUS

System design capacity

Limiting the maximum diversion time under dispatch conditions of the flight including wind and temperature.

ATA 26: Cargo fire protection

Aircraft	MOD	Description	Demonstrated protection time
A330	40041	Equipment/Furnishing Define basic lower cargo compartment	160 minutes
	40314	Extend duration of cargo compartment fire suppression	285 minutes
	40487	Install HTL Ext in FWD and AFT cargo compartment	285 minutes
	45435	Adapt extended duration for ST7 aircraft	285 minutes

System Design Capacity (Time Limited System, TLS)

Maximum authorized Diversion Time

EDTO aircraft documentation

CMP Document – Airbus CMP page layout

AIRBUS

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°:	21-1-0000-002	Revision n°14	Area of Operation: Normal
Diversion 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 9105A-21-01 AND LIEBHERR SB 956A-21-01 n°2: MOD 42628 AND MOD 42629 n°3: SB 21-3010			

Maintenance item n°:	21-2-0000-001	Revision n°7	Area of Operation: Normal
Diversion 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 closing of isolation valves and shut-off of extraction fans in case of smoke warning.			
Cross Reference: N/A			
Solutions: n°1: MPD 212800-01			

Maintenance item n°:	21-2-0000-002	Revision n°7	Area of Operation: Normal
Diversion 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 closing of cold air valve in case of smoke warning.			
Cross Reference: N/A			
Solutions: n°1: MPD 212800-02			

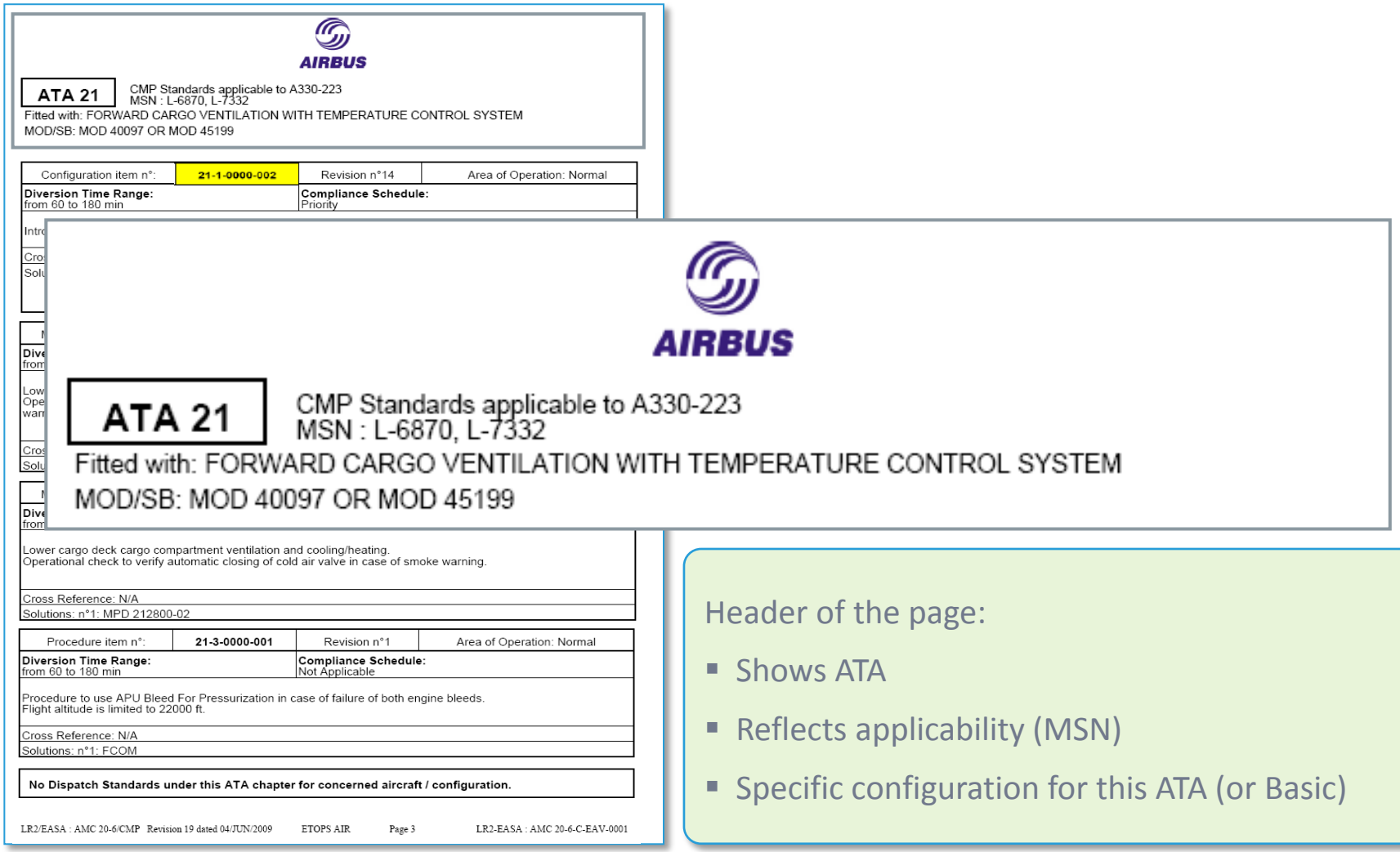
Procedure item n°:	21-3-0000-001	Revision n°1	Area of Operation: Normal
Diversion Time Range: from 60 to 180 min		**Compliance Schedule:** Not Applicable	
Procedure to use APU Bleed For Pressurization in case of failure of both engine bleeds. Flight altitude is limited to 22000 ft.			
Cross Reference: N/A			
Solutions: n°1: FCOM			

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

LR2/EASA : AMC 20-6/CMP Revision 19 dated 04/JUN/2009 ETOPS AIR Page 3 LR2-EASA : AMC 20-6-C-EAV-0001

EDTO aircraft documentation

CMP Document – Airbus CMP page layout



AIRBUS

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°:	21-1-0000-002	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 212800-02

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: FCOM

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

LR2/EASA : AMC 20-6/CMP Revision 19 dated 04/JUN/2009 ETOPS AIR Page 3 LR2-EASA : AMC 20-6-C-EAV-0001

Header of the page:

- Shows ATA
- Reflects applicability (MSN)
- Specific configuration for this ATA (or Basic)

EDTO aircraft documentation

CMP Document – Airbus CMP page layout

AIRBUS

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°:	21-1-0000-002	Revision n°14	Area of Operation: Normal
Diversion 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 9105A-21-01 AND LIEBHERR SB 956A-21-01 n°2: MOD 42628 AND MOD 42629 n°3: SB 21-3010			

Maintenance item n°:	21-2-0000-001	Revision n°7	Area of Operation: Normal
Diversion 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 closing of isolation valves and shut-off of extraction fans in case of smoke warning.			

LR2/EAS

Item contains:

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

Configuration item n°:	21-1-0000-002	Revision n°14	Area of Operation: Normal
Diversion 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 9105A-21-01 AND LIEBHERR SB 956A-21-01 n°2: MOD 42628 AND MOD 42629 n°3: SB 21-3010			

EDTO aircraft documentation

CMP Document – Airbus CMP page layout

AIRBUS

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Diversion 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 closing of isolation valves and shut-off of extraction fans in case of smoke warning.			
Cross Reference: N/A			
Solutions: n°1: MPD 212800-01			

Maintenance item n°:	21-2-0000-002	Revision n°7	Area of Operation: Normal
Diversion Time Range: from 60 to 180 min		**Compliance Schedule:** Interval: Not to exceed 2500 Flight hours	
Lower cargo deck c… Operational check t…			
Cross Reference: N…			
Solutions: n°1: MPD…			

Procedure item			
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: FCOM			

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

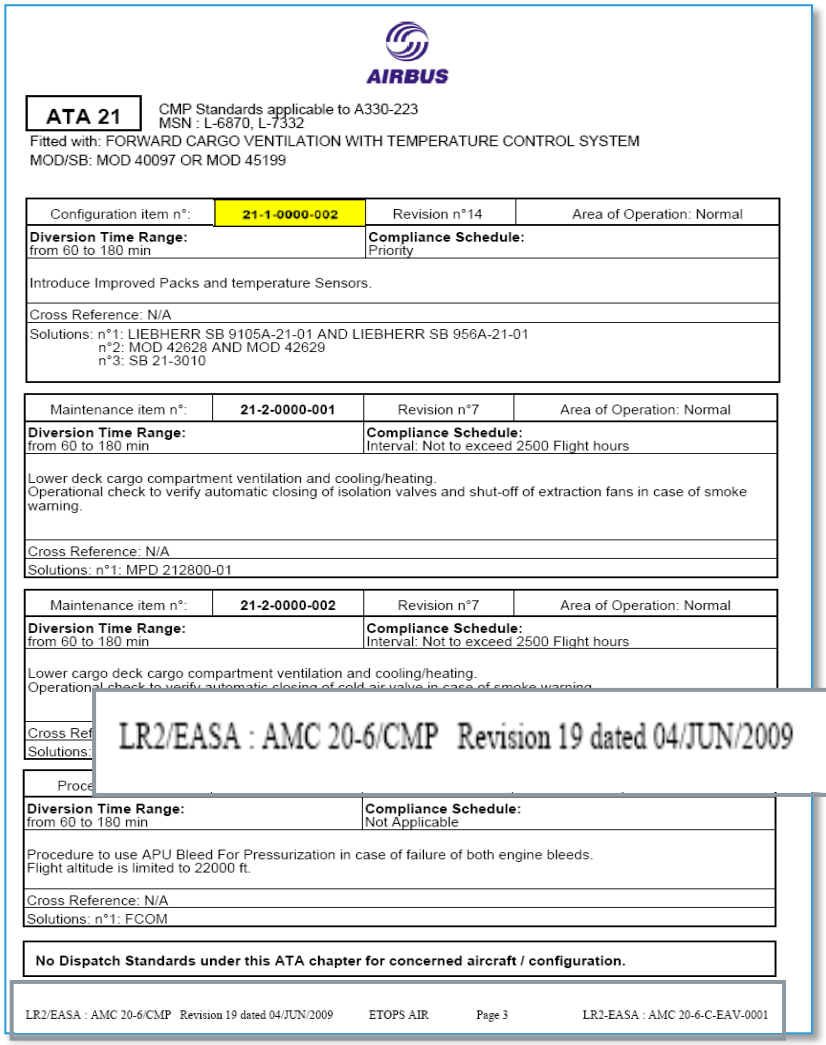
LR2/EASA : AMC 20-6/CMP Revision 19 dated 04/JUN/2009 ETOPS AIR Page 3 LR2-EASA : AMC 20-6-C-EAV-0001

Statement when no applicable standards for this ATA chapter (for concerned aircraft)

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

EDTO aircraft documentation

CMP Document – Airbus CMP page layout



AIRBUS

ATA 21 CMP Standards applicable to A330-223
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Fitted with: FORWARD CARGO VENTILATION WITH TEMPERATURE CONTROL SYSTEM
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Diversion 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 9105A-21-01 AND LIEBHERR SB 956A-21-01 n°2: MOD 42628 AND MOD 42629 n°3: SB 21-3010			

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Diversion 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 closing of isolation valves and shut-off of extraction fans in case of smoke warning.			
Cross Reference: N/A			
Solutions: n°1: MPD 212800-01			

Maintenance item n°:	21-2-0000-002	Revision n°7	Area of Operation: Normal
Diversion 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 closing of cold air valve in case of smoke warning			
Cross Ref			
Solutions:			

Proce			
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: FCOM			

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

LR2/EASA : AMC 20-6/CMP Revision 19 dated 04/JUN/2009 ETOPS AIR Page 3 LR2-EASA : AMC 20-6-C-EAV-0001

LR2/EASA : AMC 20-6/CMP Revision 19 dated 04/JUN/2009 ETOPS AIR Page 3 LR2-EASA : AMC 20-6-C-EAV-0001

Footer indicates

- CMP Reference
- Revision + Date
- Reference to customization
  (e.g. name of operator)
- Page number
- Document reference

EDTO aircraft documentation

EDTO/ETOPS Parts List

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**

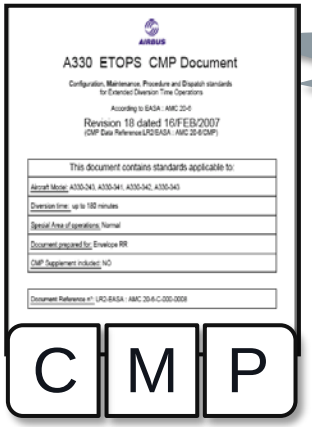
The EDTO Parts List reflects the latest revision of the EDTO CMP document.

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 **APPROVED** *(mandatory)* for ETOPS
Parts **NOT APPROVED** for ETOPS after specified end date	

IPC

Part List

EDTO aircraft documentation

Overview of AFM ETOPS supplement

AFM

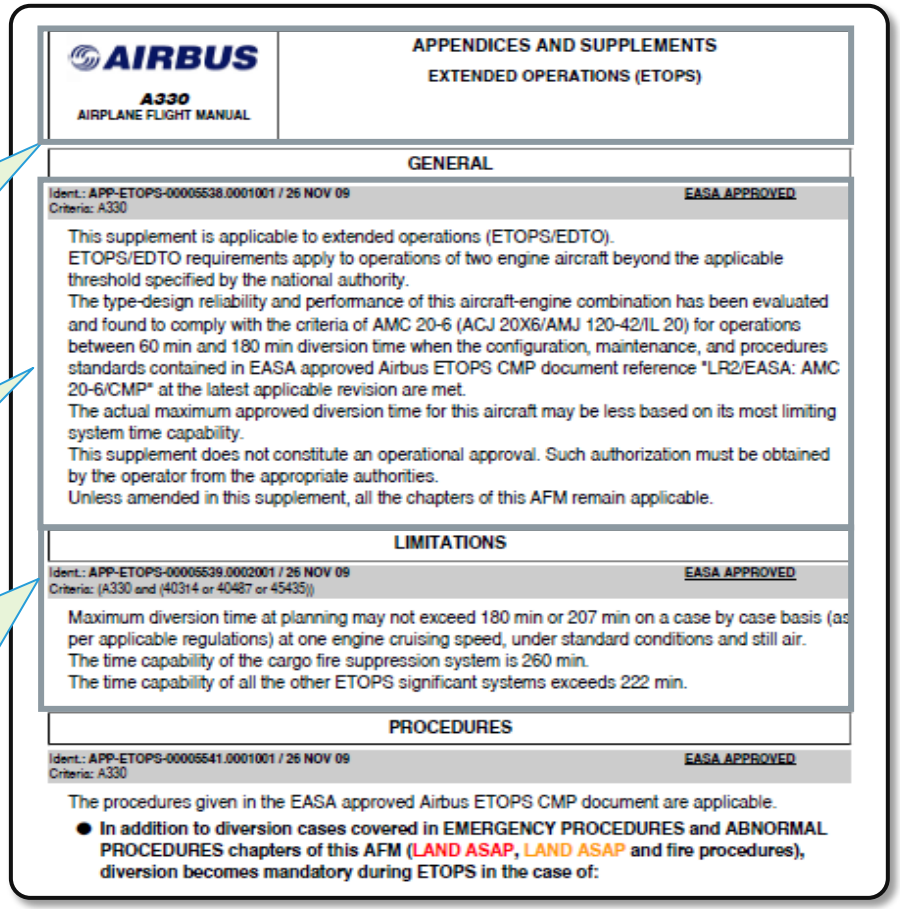
Approved AFM ETOPS Supplement

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



AIRBUS
A330
AIRPLANE FLIGHT MANUAL

APPENDICES AND SUPPLEMENTS
EXTENDED OPERATIONS (ETOPS)

GENERAL

Ident.: APP-ETOPS-00005538.0001001 / 26 NOV 09 — EASA APPROVED
Criteria: A330

This supplement is applicable to extended operations (ETOPS/EDTO).
ETOPS/EDTO requirements apply to operations of two engine aircraft beyond the applicable threshold specified by the national authority.
The type-design reliability and performance of this aircraft-engine combination has been evaluated and found to comply with the criteria of AMC 20-6 (ACJ 20X6/AMJ 120-42/IL 20) for operations between 60 min and 180 min diversion time when the configuration, maintenance, and procedures standards contained in EASA approved Airbus ETOPS CMP document reference "LR2/EASA: AMC 20-6/CMP" at the latest applicable revision are met.
The actual maximum approved diversion time for this aircraft may be less based on its most limiting system time capability.
This supplement does not constitute an operational approval. Such authorization must be obtained by the operator from the appropriate authorities.
Unless amended in this supplement, all the chapters of this AFM remain applicable.

LIMITATIONS

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

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.

PROCEDURES

Ident.: APP-ETOPS-00005541.0001001 / 26 NOV 09 — EASA APPROVED
Criteria: A330

The procedures given in the EASA approved Airbus ETOPS CMP document are applicable.

- **In addition to diversion cases covered in EMERGENCY PROCEDURES and ABNORMAL PROCEDURES chapters of this AFM (LAND ASAP, LAND ASAP and fire procedures), diversion becomes mandatory during ETOPS in the case of:**

EDTO aircraft documentation

Overview of AFM ETOPS supplement

AFM

Approved AFM ETOPS Supplement

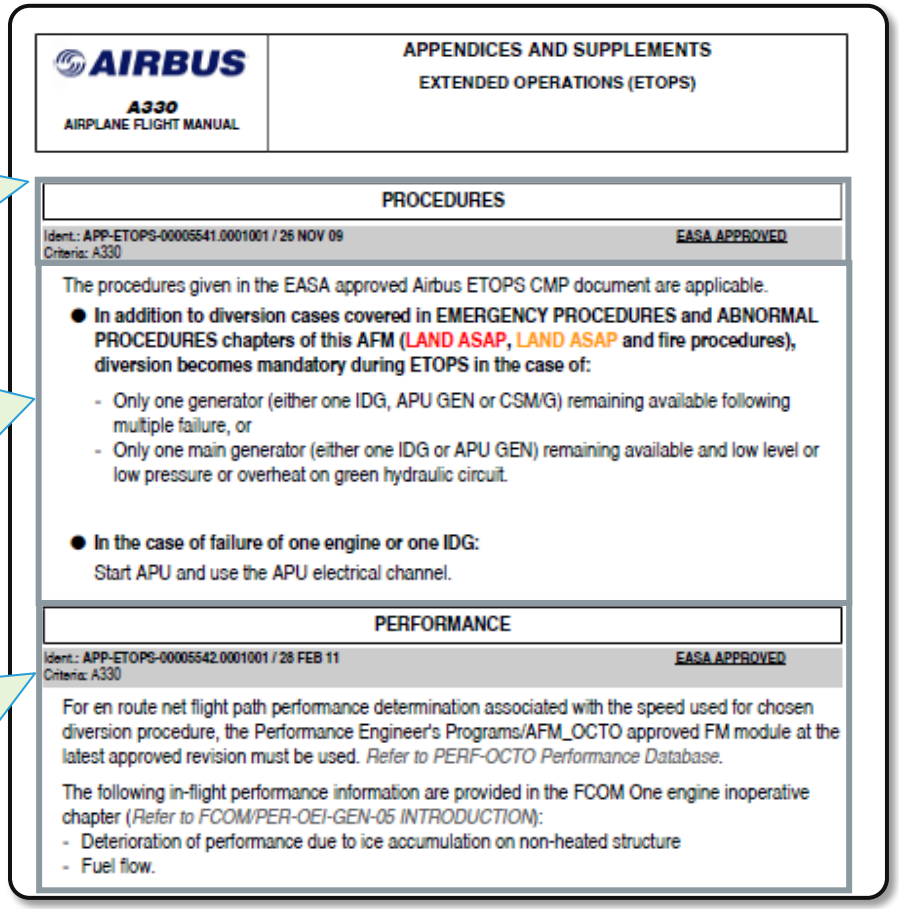
Confirms applicability of procedures listed in AFM Chapter Emergency Procedures & Abnormal Procedures (following failures & normal procedures)

Identifies additional diversion cases for ETOPS in case of:

- One generator remains available; or
- One main generator remains available, combined with lo press / low level or overheat of green hydraulic

Provides reference to applicable performance data:

- AFM module AFM-OCTO (determination of performance)
- FCOM Chapters PER-OEI-GEN-06 (Single engine operation)



AIRBUS
A330
AIRPLANE FLIGHT MANUAL

APPENDICES AND SUPPLEMENTS
EXTENDED OPERATIONS (ETOPS)

PROCEDURES

Ident.: APP-ETOPS-00005541.0001001 / 26 NOV 09 — EASA APPROVED
Criteria: A330

The procedures given in the EASA approved Airbus ETOPS CMP document are applicable.

- **In addition to diversion cases covered in EMERGENCY PROCEDURES and ABNORMAL PROCEDURES chapters of this AFM (LAND ASAP, LAND ASAP and fire procedures), diversion becomes mandatory during ETOPS in the case of:**
  - Only one generator (either one IDG, APU GEN or CSM/G) remaining available following multiple failure, or
  - Only one main generator (either one IDG or APU GEN) remaining available and low level or low pressure or overheat on green hydraulic circuit.

- **In the case of failure of one engine or one IDG:**
  Start APU and use the APU electrical channel.

PERFORMANCE

Ident.: APP-ETOPS-00005542.0001001 / 28 FEB 11 — EASA APPROVED
Criteria: A330

For en route net flight path performance determination associated with the speed used for chosen diversion procedure, the Performance Engineer's Programs/AFM_OCTO approved FM module at the latest approved revision must be used. *Refer to PERF-OCTO Performance Database.*

The following in-flight performance information are provided in the FCOM One engine inoperative chapter (*Refer to FCOM/PER-OEI-GEN-05 INTRODUCTION*):

- Deterioration of performance due to ice accumulation on non-heated structure
- Fuel flow.

ETOPS Type Design Compliance

Section 3 of Airplane Flight Manual (AFM)

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.

Operational Data Section of AFM

BOEING

787 Airplane Flight Manual

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 it 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**.

Example Language

MMEL

MMEL ETOPS Items

Dispatch restrictions specific to ETOPS are identified in the basic MMEL

Example:

24-25-02	Manual Transfer (ALTN Function) of AC ESS FEED Control to AC BUS 2

Ident.: MI-24-25-00007111.0001001 / 22 MAR 10
Applicable to: ALL

24-25-02A

Repair interval	Nbr installed	Nbr required	Placard
C	1	0	Yes

(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.

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

Agenda

- 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

Conclusion (1/2)

- 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,…

Conclusion (2/2)

- 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

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

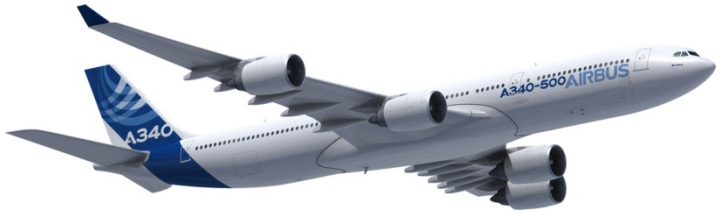
- ETOPS beyond 180 min for all A330 Pax models
  - 1700 NM, equivalent to ~240 min (ISA, Still Air)
- A330-200F models approved for ETOPS 180 min

- 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

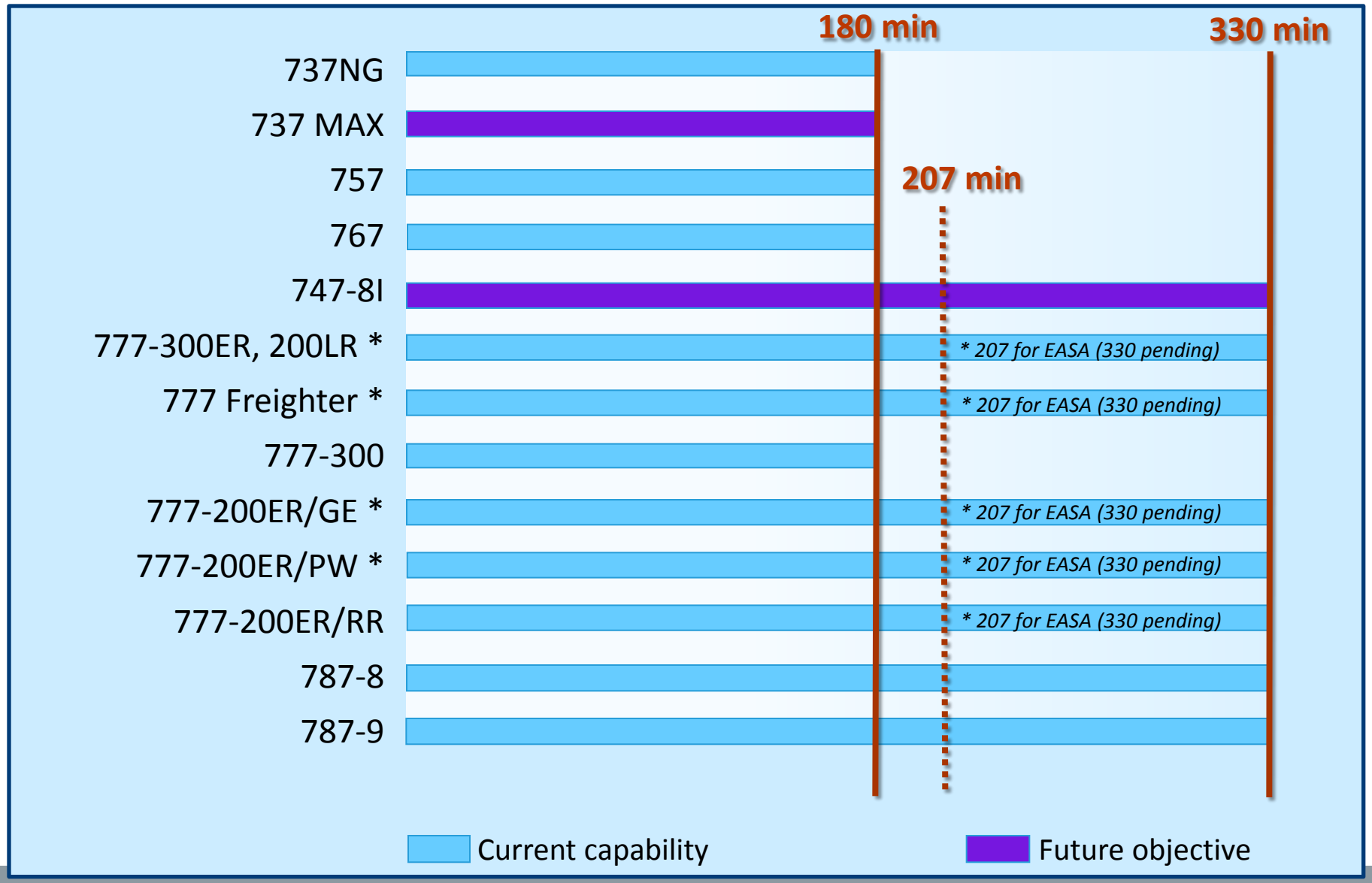
A380
- 240 min Cargo Fire Suppression capability

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

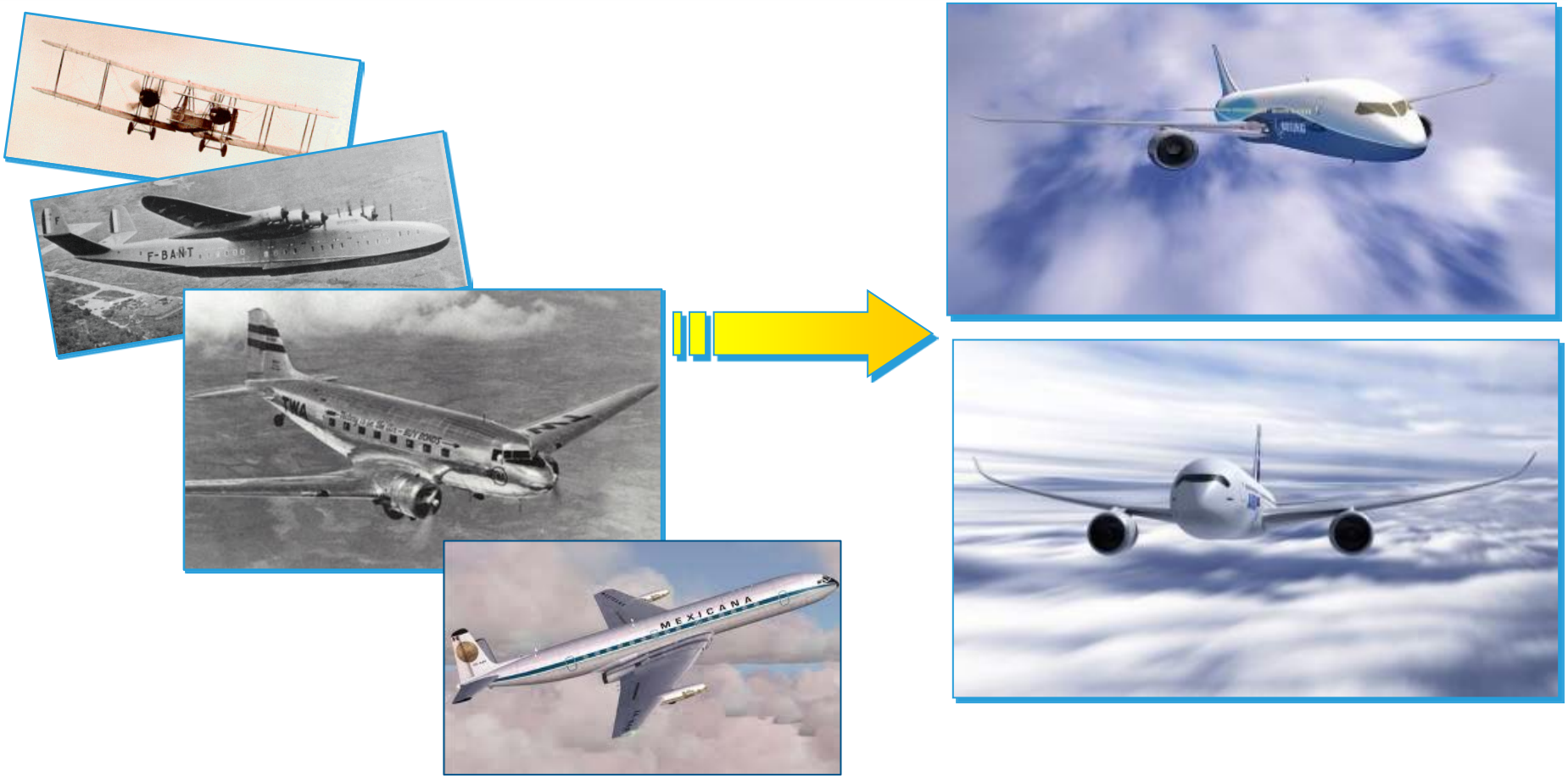


A340-500 / -600
- 285 min Cargo Fire Suppression capability

ETOPS Design Capabilities and Objectives Summary



Module 4
EDTO Aircraft Certification Considerations



Thank You !!