The European Association of Aerospace Industries

AECMA

Gulledelle 94 - b.5, B - 1200 BRUSSELS, Belgium • Telephone: (32) 2 775 81 10, Facsimile: (32) 2 775 81 11
Email: info@aecma.org - WWW: http://www.aecma.org

73362 FAA-99-6717-17 (13)

DATE: 26 May 1999
YOUR REFERENCE:
OUR REFERENCE: AECMA 20456 / 99
DIRECT LINE: (32) 2 775 81 10
FAX: (32) 2 775 81 11

Federal Aviation Administration
Office of the Chief Counsel
Rules Docket Office [29547]
800, Independence Avenue, S W
Room 915-G
Washington DC 20591
USA

Subject: Docket N° 29547 – ATA and ALPA request – 207-minute ETOPS approval criteria

Dear Sir

The attached comments from the European Association of Aerospace Industries (AECMA) concern the ATA and ALPA request petitioning the FAA to issue a Policy Letter that would permit the extension of the maximum diversion time of certain ETOPS flights up to 207 minutes (Docket 29547).

The AECMA regroups more than one thousand companies that comprise the aerospace manufacturing industry from ten countries in Europe, with airframe, engine, appliances and components manufacturers as well as service companies. However Rolls Royce, one of the AECMA members informed the organization at a late stage that they could not be involved in the commenting. It shall therefore be noted that Rolls Royce is not a sponsor of the attached comments.

In case of any question relating to this document, feel free to contact Mr. Alain Gros Secretary of the AECMA Airworthiness Committee (Telephone 32 2 775 81 10 Fax 32 2 775 81 11 e-mail info@aecma.org).

Yours faithfully

Yves Roncin
AECMA ETOPS Coordinator

AECMA

Federal Aviation Administration Washington DC 20591	
In Re: 207-Minute Extended Range Operations with Two-Engine Aircraft (ETOPS) Operational Approval Criteria Requests for Comments	Docket N°. 29547

Comments from European Association of Aerospace Industries (AECMA)

TABLE OF CONTENTS

AECMA

Comments from European Association of Aerospace Industries (AECMA)

1 Introduction

The European Association of Aerospace Industries (AECMA) appreciates the opportunity of commenting on the request by the ATA and ALPA (Federal Register dated April 27, 1999 pp. 22667-22669) for the FAA to issue a policy for approval of 207-Minute ETOPS operations.

2 General comment on the need for formal rulemaking

Over fifteen years ETOPS has brought about radical changes in transport aircraft design and operation. It has lead to unprecedented improvements in engine reliability and several major advances in aircraft systems safety. However with the exception of the JAA in Europe who issued an ETOPS paragraph in its Operational Code (JAR OPS.1), ETOPS has no firm legal basis. It still is an exemption process against FAR 121-161 using a combination of Guidance material (AC 120-42A), various policies (some without proper traceability) and in many instances even draft papers.

Over the years, the FAA (as other Aviation Authorities) has neglected applying the safety lessons from ETOPS to other types of operations. Only Transport Canada made an attempt to extend relevant elements of its ETOPS criteria to all extended range operations. Although Airbus Industrie demonstrated compliance for its four-engine aircraft the A340, Boeing chose to request dispensation for the B747-400.

The AECMA is much concerned that the safety focus from the early days of ETOPS may be lost. We recommend that the FAA discontinues its past practice of “rulemaking” by policies and informal papers on the subject of ETOPS. A comprehensive review of the service experience of ETOPS and other extended range operations should be undertaken to re-assess the existing ETOPS criteria and policies and replace them by a consistent set of regulations for all extended range operations. The present situation may only lead to inconsistencies and possibly to safety problems.

The European JAA has recognized the need for formal rulemaking to turn the original ETOPS criteria into Extended Range Operations rules. They have notified the FAA of their willingness to cooperate on this subject.

3 Safety impact of the ATA / ALPA proposal

The FAA policy to allow case by case increase of the diversion time from 120 minutes up to 138 minutes over the North Atlantic fulfills two objectives:

- Operators may avoid alternates in the Greenland (Sondre Stromfjord, Thule and Narsassuac) that present very severe winter conditions. This is clearly in the interest of operational safety.

- Operators may avoid a small percentage of flight cancellations when several alternates fall below ETOPS visibility planning minima. This constitutes a commercial advantage since the only fallback would be non-ETOPS re-routing.

The ATA / ALPA proposal to allow case by case increase of the diversion time from 180 minutes up to 207 minutes over the North Pacific has only a commercial dimension and lacks a safety benefit:

- Simulations performed on the North Pacific have shown that the 207 minute diversion time would be used to avoid the slightly longer Southern route based on Midway airport and use instead the shorter Northern route based on the Arctic alternates. This would concern between 10 and 20 percent of the flights, mostly in the winter when the Arctic alternates are presenting the most severe safety problems.
- There is no consideration in the proposal for using the proposed 15% increase in diversion time to privilege the use of the alternate airports with safest operating environment and ground equipment.

The AECMA recommends that the criteria that define "suitable" airports be reviewed to acknowledge the safety significance of such parameters as iced-up runway, snow, cross-wind, unsafe low ground temperature, lack of RFFS equipment and lack of other airport safety equipment.

4 Safety objectives of ETOPS

The original ETOPS criteria were written at a time when the engine technology did not allow full compliance with the "safety objectives" of FAR 25.1309. The "safety objectives" define the relationship between the maximum acceptable probability of occurrence of any combination of failures and its consequences on safety.

In the case of ETOPS, complete loss of thrust from both engines leads to a "catastrophe" and must be "extremely improbable" (10^{-9} per flight hour).

A diversion caused by an engine failure is a "major" situation (unfamiliar airfield, prolonged use of the "abnormal" procedures) and it must be "improbable" (10^{-5} per flight hour). However in areas such as the North Pacific and the Arctic zones the extreme winter conditions at diversion airports would impose to classify a diversion as a "hazardous" event thus requiring a probability of occurrence below 10^{-7} per hour. This challenging objective may require special design and reliability criteria even for a three or four engine aircraft. The expected traffic growth in these areas over the next ten years requires a complete review of the existing rules.

The engine that served as a reference for the original ETOPS criteria was the most reliable engine in the world fifteen years ago. It only had a rate of in-flight shut downs (IFSD) of .05 per 1000 engine operating hours. This corresponds to a probability of diversion of 1 per 10,000 hours and to a probability of double engine failure of 8×10^{-9} per flight hour, both well in excess of the FAR 25.1309 requirements.

Note: The ICAO formula for the calculation of the probability of a double engine failure in ETOPS is P_{2eng} = 4 x (Mean D.T.) x $(\text{IFSD Rate})^2$

The FAA (and the other Aviation Authorities) instituted a process of continued reliability monitoring of the ETOPS fleet by a group of experts (PSRAB). The FAA mandated reliability improvements to correct all detected engine IFSD events via an approved document, the ETOPS Configuration, Maintenance and Procedures Document (CMP). This process effectively lead to outstanding improvements in engine reliability. The latest generation of ETOPS aircraft (A330 and B777) and their engines (PW 4000, RR Trent and GE 80) now fully comply with the safety objectives of FAR 25.1309 when the flights are conducted in areas of operation (North Atlantic, Central Atlantic, Indian Ocean, Central Pacific) where the mean diversion time remains less than 120 minutes.

However a substantial increase in the average diversion time and length of the ETOPS sector (as observed over the North Pacific routes) would bring the level of safety back to what it was fifteen years ago. Meanwhile, the size of the ETOPS fleet has considerably increased and an accident will become a real possibility.

The ATA / ALPA request proposes a limit IFSD rate for the engines of .019 per 1000 operating hours. This would not suffice to restore compliance with FAR 25.1309 considering the longer mean diversion time over North Pacific routes. It also fails to recognize the reliability of state of the art engines that should constitute the new reference for any ETOPS rulemaking. Under this proposal today's engines might suffer a doubling of their current IFSD rate and still be eligible for operation in the extreme environment of the North Pacific.

ETOPS engine	Actual IFSD rate	ATA / ALPA proposal
RR Trent	.004 per 1000 hours	.019 per 1000 hours
PW 4000	.007 per 1000 hours	
GE 90	.010 per 1000 hours	

The ATA / ALPA proposal leads to a probability of double engine failure over the North Pacific routes (considering the typical mean diversion time for these routes) of 3×10^{-9} / FH. This probability largely exceeds the limit in FAR 25.1309. As engine technology now allows full compliance with this rule the AECMA sees no reason to set such a relaxed reliability objective for the engines.

The AECMA has an additional concern with a policy implemented by the FAA to discontinue the PSRAB process and freeze the content the ETOPS CMP Document. This policy has removed the driving force in the continuous process of improvement of the engine reliability. The PSRAB process and the CMP were the compensating factors in the original ETOPS criteria to overcome the initial non-compliance with FAR 25.1309.

The ATA / ALPA proposal fails to offer a solution to preserve the level of safety reached by the ETOPS fleet in compliance with FAR 25.1309. The AECMA is in favor of re-instating the PSRAB process if ETOPS over the North Pacific became permitted.

5 Type design approval

The ETOPS eligibility of an airframe-engine combination is formalized by a statement of approval from the FAA in the approved Aircraft Flight Manual (AFM). (and in the Type Certificate Data Sheet - TCDS). This ETOPS approval contains a statement of the approved maximum diversion time at the single engine speed in still air. This statement constitutes a limitation for the operation of the aircraft.

The FAA policy of allowing 138 minute ETOPS at deviation from some of the operational criteria applicable to 180 minute ETOPS applies only to aircraft whose type design and reliability fully complies with the criteria for 180 minutes.

The contemplated 207-minute policy would constitute an authority to operate beyond the diversion time limitation stated in the ETOPS AFM (and TCDS).

The AECMA considers that this presents legal difficulties that could only be resolved through a re-assessment of the type design and reliability against revised ETOPS criteria.

6 Area of operation

Although existing ETOPS criteria are essentially based on the maximum diversion time in still air and ISA temperature conditions, the FAA recognized the need to adopt specific criteria for areas of operation that present unique characteristics other than the diversion time with a significant impact on safety.

The area between the coastal airports of the Northeast USA and the Caribbeans is declared "benign" and is the subject of specific less severe criteria in AC 120-42A Appendix 5.

The area between the US West coast and Hawaii is declared a "low icing threat" zone and is the subject of less severe ice protection and fuel reserves policies.

Other Aviation Authorities have similarly adopted specific ETOPS criteria or policies for specific operating areas in recognition of their uniqueness. These designated areas of operation are subject to criteria that are either more or less severe than the ETOPS baseline depending on their conditions:

- North Canada coast to coast winter operations,
- East Africa desert night operations,
- East Siberia Russian domestic routes.

The Chairman of the ICAO Council stated that operations over the new routes currently in preparation in the Arctic area require a re-evaluation by the ICAO of the factors that may affect the safety of operation in particular in the case of winter diversion.

The environment conditions in the area of operation are often of more significance to the operational safety than the diversion time.

The main extended range areas of operation worldwide are:

- The "benign" areas (Caribbeans, China Sea, Philippines Sea, Indian Ocean, Bay of Bengal, Australian desert)
- The North and Central Atlantic
- The North Pacific
- The Arctic zone (North Siberia and the Arctic Ocean)
- The South Pacific and Antarctica.

	Benign areas	Atlantic	North Pacific	Arctic zones	South Pacific
ETOPS sector (minutes)	≤ 100	≤ 150	≥ 400	≥ 540	≥ 600
Mean diversion time still air	≤ 60	≤ 60	≤ 130	≤ 110	≤ 300
Wind and ΔISA effect on D.T.	≤ 10	≤ 15	≤ 30	≤ 30	≤ 45
Mean extra time to next alternate	≤ 15	≤ 18	≤ 120	≤ 120	NA
Ground equipment	Excellent	Excellent	Poor	Extremely poor	Excellent
Winter ground temperature	Safe	Safe	Unsafe	Dangerous	Safe
Ice and snow	NA	Moderate	Severe	Extreme	NA
RFFS	Excellent	Excellent to correct	Poor	Poor to insufficient	Correct
Communications	Excellent	Correct	Poor	Poor	Poor
Volcano threat	NA	NA	High	NA	High

The winter temperatures and wind conditions at Arctic alternates completely prevent to consider a conventional evacuation after landing. Physiologists of the European Authorities have determined that most of the evacuees would not survive after only a few minutes on the ground. However few Arctic airports are equipped with the type of rescue vehicles that would allow a reasonably safe and quick evacuation of the occupants.

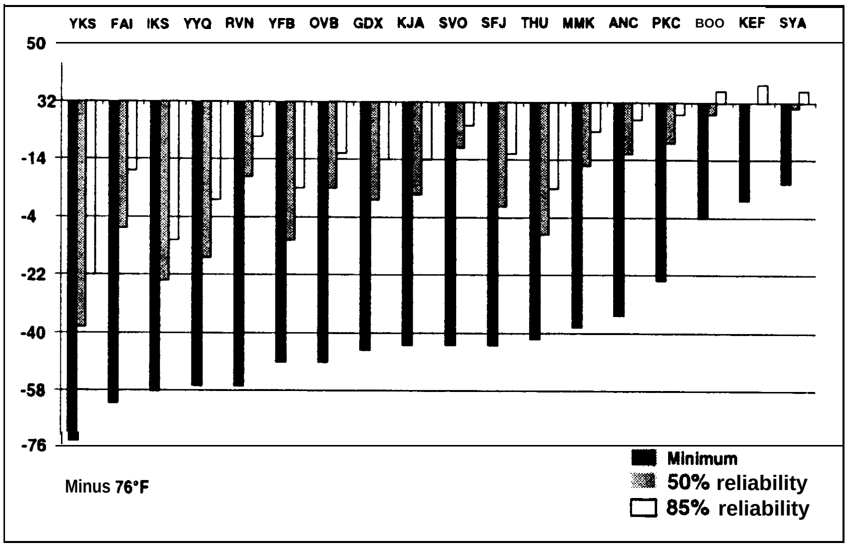
The AECMA recommends that ETOPS criteria be revised to clearly separate the aspects that directly relate to the diversion time and length of the ETOPS sector and those that relate to the operating environment of the area.

The area of operation initially contemplated in the ATA / ALPA proposal requires a review of the risk model of ETOPS due to the increase in mean diversion time and length of the ETOPS sector.

In addition, ETOPS over the North Pacific also requires a review of the definition of “adequate” and “suitable” alternate airports due to the extreme winter conditions and poor ground equipment.

Since no provision in the proposal seem to exclude that it is applied at some later date to operations in the Arctic zone, the safety impact of winter conditions and insufficient equipment at alternate airports may become even more critical.

Winter temperatures at alternate airports



The accuracy of the weather forecast and of the weather observations at the concerned airports needs to be checked.

The Russian weather services issue only three weather forecasts per day for this region.

The US National Climatic Data Center lacks recent data for Shemya (no data since 1995). All the data concerning the airports in the Aleutian Islands are from cooperative stations, in the absence of organized weather services and they present significant gaps.

7 Safety aspects not covered by current ETOPS experience

Unique aspects of the North Pacific operations and of operations in the Arctic zones require research and development work to overcome the absence of usable data from the current ETOPS experience.

7.1 Human factors

Human factor aspects of very long diversions need in-depth assessment. The mean diversion time on the North Atlantic is less than 60 minutes while on the North Pacific it will be in the order of 130 minutes with a possibility that the wind increases it up to 175 minutes. Contrary to what exists on the North Atlantic, during most of the flight, the fuel reserves will only allow one alternate leaving no choice to the crew.

7.2 Cabin and cockpit temperature in case of failure of air bleeds

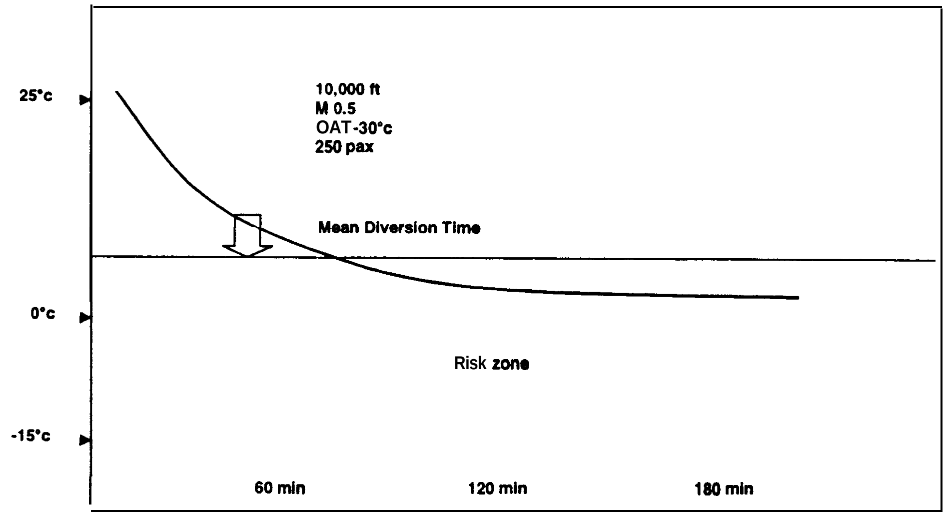
The outside air temperature and exposure time over the North Pacific routes and other Arctic routes modifies the probability and the consequences of a failure combination leading to the loss of all bleed air sources.

On these routes the cabin and cockpit temperature in case of loss of all bleed air sources may drop to a life threatening low level. Compliance with FAR 25.1309 is no longer achieved unless a third bleed source is provided.

The following diagrams were calculated with a program simulating thermal exchanges with a generic typical large twin-aisle aircraft cabin.

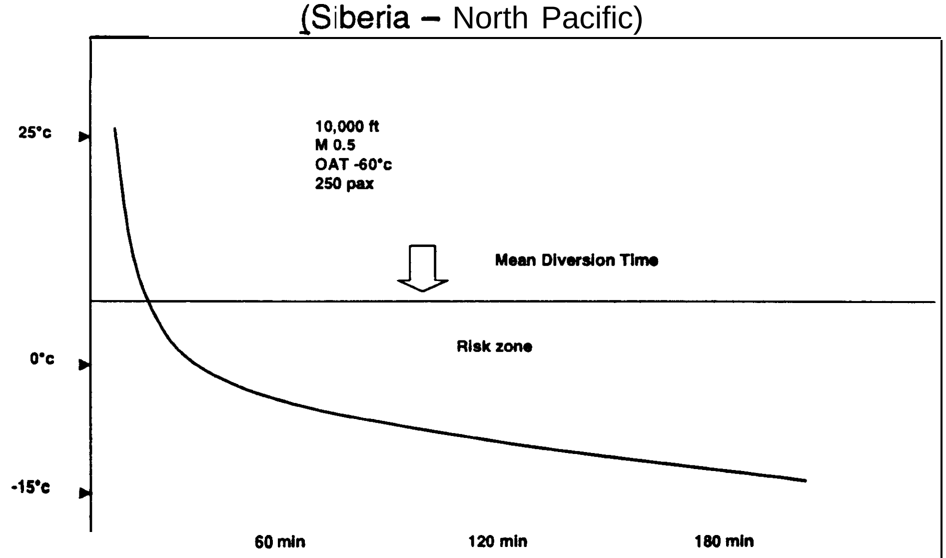
The temperature decrease is steeper if the number of passengers onboard is reduced below 100%. The decrease in the cabin temperature may be somewhat reduced by increasing the percentage of re-circulated air at the detriment of the concentration in carbon dioxide. However such a solution is not acceptable in the cockpit that must receive 100% fresh air (FAR 25 requirement).

Typical North Atlantic winter mission



Typical Arctic winter mission

(Siberia – North Pacific)



The APU and the APU air bleed system therefore become critical systems that shall have a high level of reliability and sufficient performance. The ability to start the APU after prolonged cold soak of its oil system is critical. The APU bleed system must be able to provide enough air at a sufficient temperature without forcing the crew to fly at a very low altitude.

7.3 Engine fan blade rupture and rotor imbalance

A rupture of an engine fan blade on a very large engine may cause a high level of vibrations that transmit to the aircraft structure. The structural consequences of such vibrations depend on the diversion time. The impact of such vibrations on the ability of the crew to perform its duties is also a function of the diversion time.

8 Detailed comments on the ATA / ALPA proposal

The AECMA has a number of additional concerns that relate to specific elements in the ATA / ALPA proposal.

8.1 Discussion Section - Paragraph b

The 138-minute ETOPS policy may not be considered a precedent. This policy does not permit the operator to exceed the 180 minutes limit stated in the ETOPS type design and reliability approval of the concerned airframe-engine combinations. On the contrary the ATA / ALPA 207-minute proposal would allow to exceed this legal and technical limit.

8.2 Approval basis Section – Paragraph 1

In the ATA / ALPA proposal SATCOM becomes the prime means of long distance communication. As such it should become an essential load that remains powered under all normal and emergency electrical configurations.

Furthermore, the effective capability to communicate with the alternate airports early in advance for updated weather and runway conditions and activation of the fire fighting and rescue services needs to be demonstrated.

The alternate airports are not equipped to receive direct SATCOM messages. Indirect communication would require an appropriate organization on the part of the airlines and depend on the reliability of international telephone communication between the USA and East Siberia.

8.3 Approval basis Section – Paragraph 4

The SATCOM, the APU and the APU bleed systems are necessary to ensure the operational safety in the contemplated area of operation irrespective of the diversion time. Their presence is the result of:

- The long distance communication difficulties (SATCOM rather than HF), and
- The cabin and cockpit temperature risk (APU / APU bleed as third air bleed source).

It would not be safe to dispatch with such equipment inoperative even on days when the diversion time is 180 minutes. This raises questions about the validity of the current ETOPS criteria that do not contain such area-specific provisions.

8.4 Approval basis Section – Paragraph 5

The level of ground equipment to ensure a safe evacuation at Arctic airports in the winter is not covered by the current definition of RFFS in ICAO Annex 14. Under the temperature and wind conditions that prevail at these airports, a conventional evacuation is impossible. Specially designed rescue vehicles are needed. The flight and cabin crews have to be specially trained to handle all possible diversion scenarios including the impact of Arctic winter conditions.

During an accident occurred in Russia, in spite of the rapid action of the RFFS, the occupants of an aircraft that performed a forced landing short of the runway all died from the cold temperature.

The impracticality of conducting a conventional evacuation in the winter imposes a review of the minimum level of RFFS with a special attention to the time required for the fire fighting equipment to be deployed around the aircraft.

The AECMA recommends that the criteria defining "adequate" and "suitable" airport be reviewed. We note that in this section the ATA / ALPA proposal wrongly refers to "adequate" airports only.

8.5 Airframe-engine Section – All paragraphs

The airframe-engine section appears to contradict the ATA / ALPA declared intent that the policy should not require an ETOPS recertification of the airframe-engine combination.

8.6 Airframe-engine Section – Paragraph 1

The numerical part in the "systems safety assessments" (SSA) that demonstrates the compliance of the airframe-engine combination is certainly affected by the change in maximum diversion time. However this is not the only concern to be addressed. The "category of effects" of the failure combinations as defined per FAR 25.1309 may be affected (actually aggravated) by the operating environment and alternate airports conditions. Whenever the category of effect changes, the maximum acceptable probability of occurrence is changed. This may dictate design or procedure changes.

An example of this situation is the consequence of the failure of all air bleed systems that may have "catastrophic" instead of "major" consequences when the outside air temperature at 10,000 ft is very low. This requires a third reliable air bleed source (i.e. the APU).

The consequences of all the failure scenarios in the SSA that lead to a diversion have to be reviewed taking into account the extreme conditions at the alternates. This review may indicate that the final effect of diverting under some degraded configurations becomes worse and thus requires a lower probability of occurrence.

8.7 Airframe-engine Section – Paragraph 2

The ATA / ALPA proposal concerning the engine oil supply is unnecessary. The engine oil consumption does not significantly increase at Maximum Continuous Thrust (MCT). The oil consumption during a four hours diversion at MCT may in no case exceed the capacity of the engine oil tank that is designed to support the oil consumption for one or more flights of more than 15 hours duration each.

8.8 Airframe-engine Section – Paragraph 3

The ATA / ALPA proposal for the cargo holds fire protection time does not take into account the considerable effect of the wind and below-ISA temperature on the North Pacific routes. The proposed protection time of 222 minutes is insufficient to cover a diversion from the critical point to landing in 85% of the westbound flights. In addition, because a conventional evacuation is impossible at the Arctic airports during the winter, a substantial safety margin must be considered between the landing and the evacuation of the last occupant.

The Airbus Industrie A340 is an example of four engine aircraft designed for "extended range". Its fire extinguishing system offers a cargo hold fire protection time in excess of 260 minutes. The two-engine Airbus A330 offers the same protection time.

8.9 Airframe-engine Section – Paragraph 6

The ATA / ALPA proposal is based on a maximum engine IFSD rate that does not ensure compliance with FAR 25.1309 and ignores the higher reliability of recent ETOPS engines.

8.10 Airframe-engine Section – Paragraph 7, 6 and 9

The ATA / ALPA proposal concerning the services to remain powered in emergency electrical configuration is a step backward from state of the art ETOPS design. Only some of the first generation ETOPS aircraft of the oldest design (B737, B757, B767) do not meet the ATA / ALPA proposed criteria. The B777 and all Airbus ETOPS aircraft are offering a far superior level of technical services in case of emergency electrical configuration.

The JAA ETOPS Criteria (IL 20) contain a comprehensive list of services that was defined in close coordination with the FAA experts on the basis of a review of the service experience with the first generation of ETOPS aircraft. It is unfortunate that the FAA AC 120-42 has not also been revised accordingly, but the Special Condition that was notified for the ETOPS approval of the B777 took this list into account.

Furthermore the JAA has now turned this list of services into a general requirement for all aircraft by incorporating this list in JAR 25 (the European equivalent to FAR 25).

The AECMA may not support a reduction in safety against the design standard of modern ETOPS aircraft, considering that this was the subject of extensive coordination between the JAA and the FAA.

8.11 Executive summary: B777 Reliability study

The AECMA understands that this section is intended as indication that the contemplated change may be achieved safely with at least this particular airframe-engine combination.

However the ATA / ALPA proposal is not limited to a particular airframe-engine combination nor to the North Pacific as a particular area of operation.

The AECMA noted an inaccuracy in this section as to the increased flexibility for the crew to choose the safest alternate airport if the proposed 207-minute policy were adopted. The distance between the alternate airports in the North Pacific is such that the fuel reserves do not usually leave the crew a choice. This will not be modified by the proposed policy. This is very different from the situation over the North Atlantic where most ETOPS flights take place. The fuel reserves typically allow the crew to avoid all the Greenland airports.

9 Conclusion

The AECMA does not support the introduction of any new ETOPS criteria in the form of policies.

On the contrary the AECMA is in favor of a complete review of all the ETOPS regulatory material produced by the FAA and by the JAA (Special Condition, AC 120-42A, Policy letters, draft AC 120-42B, etc...). ETOPS was one of the key changes in the air transport world in the last two decades and deserves a legally and technically solid and consistent basis.

The AECMA is aware of the opening of new extended range routes in the Arctic regions and over the South Pacific in the near future. The traffic growth on these new routes is expected to be so high that every effort must be made right now to ensure the safety of these flights.

The AECMA recommends that the regulatory agencies focus their resources on the replacement of the ETOPS criteria by "extended range" rules for all aircraft. These rules should take into account all the significant safety parameters rather than the sole diversion time.

Safety issues relating to the area of operation will be critical features of future very long flights in the Arctic zones and over the South Pacific. The traditional concept of ETOPS will no longer be valid. The regulatory agencies should set the safety objectives at no compromise to the criteria of FAR 25.1309 without consideration of the number of engines. Two, three and four engine aircraft will require different design and procedures to achieve compliance taking into account the influence of the operating factors in the intended areas of operation.

The regulatory agencies may also have to consider the retroactive application of relevant criteria if aircraft of an older design are to be flown on some of the future Arctic routes.

The AECMA looks forward to see future regulatory initiatives concerning ETOPS and other extended range operations be primarily driven by safety considerations and not solely by commercial objectives.

A number of ETOPS flights (of both Airbus and Boeing aircraft) were affected by combinations of failures that might have prevented the crew to cope with aggravating adverse operating conditions. These events involved such situations as multiple electrical failures, multiple hydraulic failures and successive failures or malfunctions of both engines. Some of these events were caused by maintenance errors resulting in time dependent situations for the affected systems (e.g. slow oil leak or slow hydraulic fluid leak). Permission to launch ETOPS flights in areas where the operating conditions are more demanding than what is covered by today's experience may erode the safety margin that avoided these events to result in accidents. This is the case of the North Pacific and the Arctic areas at least three of these events would have had a high probability of ending in catastrophes.

The AECMA supports the global aviation safety program (GASP) of the ICAO, the CASST in the USA and the JSSI in Europe. The goal of these programs is to improve the accident rate in commercial air transport by 80%. Any new rule or policy proposal should be evaluated against this objective.