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Promet i čovjekova okolina - Traffic and Human Environment
Pregledni članak - Review
U. D. C. 656.7:502.34:534.836
Primljeno - Accepted: 20 Jul. 1996
Prihvaćeno - Approved: 4 Sep. 1996

ENVIRONMENTAL REQUIREMENTS OF AIRCRAFT OPERATIONS

SAŽETAK

EKOLOŠKI KRITERIJI EKSPLOATACIJE ZRAKOPLOVA

Respektirajući zahtjeve očuvanja i zaštite čovjekova životnog okoliša, aktualni je trenutak na općem planu označen donošenjem zakonskih normativa glede smanjenja nepovoljnog utjecaja prijevoznih sredstava.

Pooštrena ekološko-sigurnosna regulativa u zračnom je prometu usmjerena na reduciranje štetnih ispušnih plinova zrakoplovnih motora te postupnu eliminaciju bučnih zrakoplova.

Osim SAD-a, operativne restrikcije su najavile i ostale zemlje članice ICAO-a, primjerice zemlje ECAC-a, Australija, Japan i Novi Zeland.

Usprkos povoljnom geoprometnom položaju i tendenciji uključivanja u prometne tokove Europe i svijeta, Hrvatska je u procesu svog osamostaljenja, obrane vitalnih nacionalnih interesa i organizacije civilne zrakoplovne vlasti, zakasnila s implementacijom aktualnih međunarodnih normi glede ekoloških kriterija eksploatacije zrakoplova

1. INTRODUCTION

The dynamics of the global economic development has, apart from all the positive connotations that can be noticed in the improvement of general standard of living, marked the end of 20th century by recognizing the necessity for environmental protection.

The increasingly strong environmental consciousness has made all the industries assess the adverse effects of their activities on the environment. The same applies for commercial aviation.

Financial institutions nowadays are far readier to grant credits to companies which have already implemented the eco-prevention system, than to those that have to pay for the "clean-up" costs, the ecological safety regulations are becoming more rigorous, and the new economic policy regarding taxes, fees, and market licenses rewards the "green" companies and penalizes the polluters.

At the United Nations Conference on Environment and Development (UNCED), better known as the Earth Summit, held in Rio de Janeiro in 1992, the main interest was on the interaction of the principal environmental problems and economic development. As a conclusion the actions plan "Agenda 21" had been accepted.

The International Civil Aviation Organization (ICAO), as a UN agency authorized for the development of international civil aviation has taken the leading role in the standardization of the environmental - safety regulations in aviation.

The main environmental criteria related to the international commercial aviation include the aircraft noise, aircraft engine emissions, waste material handling, and ground and water contamination at airports.

The aircraft noise problem came to the fore at the end of the 1960s and the opposition of local housing communities rendered it impossible for many airports to expand their facilities and increase their traffic.

Since the reduction of noise at its source (aircraft engines) is the most efficient measure, standards for homologization of the new and the existing aircraft types i.e. for issuing of certificates depending on the aircraft weight and the number of engines have been globally determined.

The regulations with engineering specifications for the two main aircraft categories are included in the first part of the adopted Annex of the Chicago Convention[1].

Jet aircraft, mainly used in the international commercial air traffic, are categorized into two groups: aircraft manufactured prior to October 1977, meeting the requirements specified in the second part of Annex 16 (Chapter 2 or Stage 2), and aircraft manufactured following that date, which meet the more rigorous regulations of the third part of Annex 16 (Chapter 3 or Stage 3).

The first generation of jet propelled aircraft, e.g. Boeing 707 and Mc Donnell Douglas DC-8, not covered by Annex 16, has been included in the NNC-aircraft category[2], according to the noise level unacceptable for exploitation.

[1] ICAO - Annex 16, Part 1 - Environmental Protection - Aircraft Noise
[2] NNC - Non Noise Certificated

Although the noise level at airports has been and is being reduced recently due to the new and less noisy aircraft in use, the aircraft noise is still the main problem, especially at busy airports in the developed countries.

Therefore, many countries have imposed operational restrictions for noisy aircraft and have become noise-restricted areas[3] for airlines whose fleet exceeds the "Chapter 3" noise limitations.

1980 has seen the limitations for NNC-aircraft category, and their exploitation was prolonged up to 1988 by the ICAO resolution.

During recent years the restrictions have been directed to "Chapter 2" aircraft category, e.g. B-727 and the older types B-737 and DC-9.

At the special meeting in 1990, the ICAO Council accepted the resolution on the policy of operational restrictions which are to coordinate the interests of the highly developed and the developing countries, as well as the interests of airlines, airports, and environment.

The accepted scheme plans a gradual ban on the "Chapter 2" aircraft category during the period from 1995 till 2002, with certain exceptions in order to avoid an economic breakdown and to alleviate the negative effects the restrictions might cause the airline companies with older fleet.

The gradual introduction of a noiseless fleet of "Chapter 3" aircraft will not only solve most of the noise pollution problem, but also make it possible for the airports to work at night, i.e. to efficiently increase the traffic by lifting the "night-curfew".

In the analysis of the harmful aircraft engine emissions there should be a distinction between the problem of the local air quality in the airport vicinity and the problem of the global pollution of atmosphere.

The ratio of aircraft engine harmful emissions vary in percentages during approach, landing, rolling, take-off and the initial phase of rising from the ground.

The worst pollutants in these emissions are nitric-oxide, carbon monoxide, unburned hydrocarbonate and smoke.

In 1981, ICAO standardized the harmful emissions control i.e. the conditions for the aircraft engine certificates, in the second part of the Annex 16.

The regulations specify the limitations for three harmful exhaust gases for the new aircraft engines in the so-called LTO-cycle[4].

Solving the problem of engine emissions within the airport sites is exposed to two mutually opposing trends: the introduction of "clean" airports, and also the increase in the number of aircraft operations.

The ICAO Council has in 1993 conditioned the manufacturing of new aircraft engines by the reduction of the allowed amount of NOx by 20%.

[3] USA, Australia, Japan, ECAC countries and New Zealand

[4] Landing and Take off Cycle

Aircraft engine emissions show adverse effects also within the global environmental problems such as atmospheric pollution, mainly of the upper layers, depletion of the ozone layer, greenhouse effect and the acid rain, as well as global rise of temperature.

These problems have been identified as, viewed in the long run, very serious and a threat to the life on Earth.

The main eco-activities of ICAO involve solving of problems regarding aircraft noise and harmful engine emissions, so that other environmental requirements in aviation occur (and for the present are being dealt with) as single local problems mainly related to the airports exploitation.

Various aspects of the problem of ground and water contamination due to airport activities, such as de-icing and prevention of ice-formation on aicrafts and operational surfaces, fuel storing and handling, aircraft and service vehicles maintenance, fire-prevention activities and use of pesticides, as well as waste management problems are dealt with in the airport planning manuals.

2. IMPLEMENTATION OF THE ACCEPTED INTERNATIONAL REGULATIONS

It has been mentioned in the introduction that the ICAO member states have already in 1980 made the first resolution related to the environmental protection, primarily in reducing noise.

The regulations are to be implemented gradually, i.e. during a period of ten years in order to avoid an economic breakdown, and the governments are responsible for their implementation.

The total world commercial fleet during the period of defining the "cleaning-up" plan at the end of 1987 included as many as 62% of "Chapter 2" aircraft and 5% of NNC-aircraft.

The increase in the air traffic, which from a "handful" of passengers at the beginning of this century reached the today's figure of more than one billion passengers flying annually, caused also an increase in the adverse influence of aviation on the environment and the need for more rigorous eco-regulations of exploitation.

Thus, on 1st April 1995 restrictions on noisy aircraft started to be implemented, lead by the highly developed countries by charging fines, followed in the next phase by flight-ban.

Aircraft which do not meet the "Stage 3" requirements will be banned from traffic in the European Community countries starting from 1st April 2002, and the "Stage 2" aircraft that are 25 years old have to be withdrawn from traffic even before the agreed deadline.

Only in exceptional cases can certain users be allowed to prolong the exploitation for three more years.

In the USA the "Stage 2" aircraft have to be withdrawn from traffic by the end of December 1999, and only exceptionally can a prolongation until the end of 2003 be granted.

The US operators should also reduce the number of their "Stage 2" aircraft in the fleet, in order to reduce their number by the end of 1996 by 50% and by the end of 1998 by 75%.

Aircraft that do not meet the "Stage 3" requirements cannot be entered in the civil aircraft register in the USA nor in the European countries.

Regulations related to noise measurement are almost identical for the USA (FAR 36)[5] and other ICAO members (Annex 16), which means that noise is measured at 650 m lateral distance, 6500 m from the beginning of the runway in take-off and 2000 m from the beginning of the runway in landing, and the noise level is determined depending on the maximum aircraft weight in take-off and the number of engines.

Some countries i.e. operators have made use of the possibility for the delay in the implementation of regulations in order to avoid an economic breakdown, but some have suddenly found themselves in front of a wall.

Countries with highly developed economy want to benefit from their past investments. They want a healthy nation as a precondition for further development and survival. Naturally, the environment influences the general health. Therefore, they insist on strict implementation of regulations which cannot be promptly adopted by other countries due to their economies.

This leads to various approaches in meeting the given regulations, i.e. in solving the problem.

For the most numerous aircraft fleet, such as Boeing 737-100 and -200 series and DC-9, hush-kits are produced (devices for aircraft modification in order to lower the engine noise). The modified aircraft are granted an additional homologization, which means that a "Stage 2" aircraft becomes a "Stage 3" aircraft.

The costs of eco-modification of an aircraft range from 2.4 to 3.6 million US Dollars, at the same time maintaining the same level of flight performance i.e. the possibility of using full flaps, the same amount of specific fuel consumption, and in Boeing 737-200 aircraft with powerful engines (JT8D-17/17A) also the possibility to increase the maximum take-off weight, thus doubling the benefits of modification.

The additional enhancement of modification and hush kit of aircraft MD-80 and Boeing 707 on engine JT3D is in its final phase.

A different approach to implementation of noise regulations can be noted between the European and the US operators. Whereas a great number of US operators order modification kits for noise abatement for the existing aircraft modifying the existing fleet, European operators opt for purchasing new aircraft and completely replacing the old ones.

According to the experiences of manufacturers and buyers, the reasons for such decisions are mainly economic ones and include the following:

- in Europe the operators with "Stage 2" fleet have to pay up to 300% higher landing taxes than for "Stage 3" aircraft.
- some aircraft modified into "Stage 3" (such as Boeing 737-200, Boeing 747-100/200, Mc Donnell Douglas DC-10-10 and MD-80) still pay, e.g. in Germany, taxes higher up to 30% in relation to the new generation aircraft and can be banned from night traffic. The reason lies in the discontent of many European airports that ICAO had not adopted even more rigorous measures of noise regulation. They then determine their own regulations, thus penalizing the aircraft that just about meet the "Stage 3" requirements, such as modified aircraft or aircraft being manufactured (MD-80).
- German airports advocate the implementation of stronger noise regulation "Stage 3b", and hope that this regulation will be included in the Joint Aviation Requirement (JAR). According to their measurements there is almost no difference between the "Stage 2" aircraft and the modified "Stage 3" aircraft that are close to the limit values meeting the regulations. Many airports in Europe do not apply the so-called "acoustic-compensation" any more - the possibility of compensating for exceeding the regulated noise level in one of the three reference points by reducing the noise in the other two.
- In USA the operators have adopted the hush kit modification on the existing fleet simply because they cannot find financial means to replace many hundreds of aircraft in their fleet that have been manufactured in 1970s.
- The International Airline Traffic Association (IATA) says also that there is no need for more rigorous noise regulations, since this would result in the decrease of the aircraft market value and render the replacement of the old fleet impossible. Most of the European operators can afford purchasing new aircraft since their traffic increase trend is greater than the one achieved by the US operators, because they have not been exposed to such strong competition in the past, and because in the most cases they are directly or indirectly subsidized by government funds.

In Europe, only SAS[6] has ordered hush kits for modification of the existing DC-9 aircraft, simultaneously ordering new Boeing 737-600 aircraft that will replace the rented MD-80 and F-28 aircraft by the end of 1998, and Lufthansa which has already received hush kits for modification of Boeing 737-200 fleet, which will be gradually replaced by Airbus A-319.

[5] FAR - Federal Aviation Regulation

[6] SAS - Scandinavian Airlines

Almost all civil aircraft manufactured in the East (Russia) exceed the allowed noise level, and with no modification program their market value has drastically fallen. They are used in internal traffic, and new aircraft manufactured in the West are being purchased for the international traffic.

Apart from installing the hush kits on those types of aircraft that are being used in traffic in an insignificant number re-engining or retrofitting is performed.

3. ECO-TECHNOLOGY OF AIRCRAFT CONSTRUCTION

Aviation has always been the forerunner in applying sophisticated and innovative technology.

The world air traffic is expected to double in the next 15 years so that the advanced technology has to find solutions for meeting the flight safety as well as environmental protection requirements in the future traffic expansion.

In solving the environmental problems two approaches can be defined: the direct approach - by improving the construction and performance of aircraft engines as main sources of noise and emission, and the indirect approach - by regulating the traffic so as to minimize the local traffic density and the total time of flight, as well as by regulating the operational flight phases i.e. the initial and final operations at the airport.

Therefore, the new eco-technology involves the construction improvement of all aircraft devices and equipment, so that the new aircraft has to be less noisy and cleaner, and the equipment, primarily the one of the cockpit enhanced.

Aircraft manufacturers have to design aircraft thinking of the future, since the airlines tend to avoid the necessity of continuously investing in improvements and aircraft modifications in order to meet the increasingly demanding regulations.

Today's technology has already got answers to many requirements imposed on the aircraft of tomorrow.

Modern design and aircraft manufacturing technology has been reflected directly on the aircraft deadweight and the necessary engine power.

The aircraft construction joined by adhesion results in an up to several hundreds of kilograms lighter aircraft, increased corrosion resistance on joints, a construction more tolerant in the case of damage, and the possibility to manufacture an aerodynamically "cleaner" aircraft, that is, an aircraft with reduced resistance.

Application of non-metals, the so-called composites (ceramics, carbon fibers, aramids, glass fibers etc.) enables manufacturing of more complex and 3-dimensionally bent elements of the aircraft structures, improved aeroprofiling and aerodynamically more favorable forms as well as reduction of operational weight of the aircraft.

The sophisticated aerodynamic wing profiles and aircraft fuselage result in the reduction of resistance and greater aircraft flying arrivals.

The bearing surfaces with low structural load as a result of a smoother wing arch, and with a relatively thicker aero-profile with low resistance, eliminate the need of installing the hyper-pressure devices, reducing the maintenance costs and achieving good performance.

Engines with low specific fuel consumption and cleaner combustion affect directly the emission of harmful gases.

The development of engines with low combustion temperature, low differential pressure, provides quieter engine operation and lower emissions.

Engines are being developed with multiphase combustion, by-passing air ducts, and mixers and air nozzle guides in order to hush up the engine operation.

The propelling materials are also being studied for cleaner aircraft engine exhaust, and the studies are being carried out of completely new fuels, e.g. hydrogen.

The enhanced aircraft equipment provides better navigation, avoidance of traffic, detection of turbulence and direct exchange of messages with the flight control.

The Electronic Flight Instrument System (EFIS) provides the pilot with all the information on a monitor which, connected with the flight control service enables information exchange without the standard radio connection.

The new transponder will enable the pilot to view on the monitor other direct traffic participants, and the devices such as GPWS (Ground Proximity Warning System), ACAS (Airborne Collision Avoidance System), automatic NAP (Noise-Abatement Procedure) will provide a safe flight, less tiring for the pilot.

The tendency is to provide the pilot with a so-called dark cockpit, with lights indicating only those instruments that are needed at the given moment. Self-testing devices will be able to detect the failure and provide the technical service with the information on the possible failure even before landing.

The manufacturers expect that in the next century the supersonic air traffic could be economically justified. Therefore, in the tendency to make these SST[7] aircraft "green", hundreds of millions of dollars are spent on research carried out by NASA[8] and the engine manufacturers. However, the opposing research is also being carried out, which shows that the planned fleet of supersonic aircraft would deplete 2-3% of the remaining ozone layer in the stratosphere within a period of ten years.

NASA has allocâted 26.5 million dollars for studying the effects of introducing a global SST traffic on the atmosphere. The latest results confirm that the worst damage would be done to the ozone layer at 25-28 km above the Earth.

[7] SST - Supersonic Transport

[8] NASA - National Aeronautical and Space Agency

4. CONCLUSION

The environmental safety regulations in aviation are being globally implemented and considering the planned increase in air traffic they are expected to become more rigorous in the future.

The main technical regulations on noise and harmful gas emissions are given in Annex 16 of ICAO, and regionally the tendencies towards even more rigorous aircraft exploitation requirements can be seen, e.g. in USA by FAR, and in Europe under the Joint Aviation Authority (JAA).

Other adverse effects on the environment are also being studied and regulations defined, e.g. the aircraft engine exhaust during cruising, primarily of the supersonic aircraft, and their influence on the ozone layer depletion and atmospheric rise of temperature, ergonomic problems such as vibrations.

New eco-technology includes the design enhancement, not only of the engine as the main harmful source, but also of other aircraft devices and equipment, thus becoming the primary condition for aircraft exploitation.

The explosions of bombs have only recently quieted down in Croatia, and the smoke from war destruction has cleared up, and we find this air and such quietness satisfying. But the world will close its door upon us if we do not undertake more towards meeting the regulations of our neighbors within the already set deadlines.

SUMMARY

Respecting the requirements for preservation and protection of the environment, the present day is marked by implementation of legislative regulations in order to reduce the adverse effects of transport vehicles.

The increasingly strict eco-regulations in air traffic are aimed at reducing the aircraft engine emissions and gradual elimination of noise producing aircraft.

Apart from the USA, operational restrictions have been announced also by other ICAO members, such as the ECAC countries, Australia, Japan and New Zealand.

In spite of a good geo-traffic position and the tendency of integration into the European and world traffic routes, Croatia has found itself, due to the process of gaining independence, defending its vital national interests and organization of civil aircraft authorities, lagging behind with the implementation of the present international regulations regarding environmental protection criteria in aircraft operations.

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