ENVIRONMENT AND AIR TRAFFIC NOISE

IGOR ŠTIMAC, B.Eng.
E-mail:igor.stimac@inet.hr
Zračna luka Zagreb
Pleso bb, 10000 Zagreb, Hrvatska

JURICA IVANIŠEVIĆ, B.Eng.
E-mail:juricaivanisевич@net.hr
Zračna luka Zagreb
Pleso bb, 10000 Zagreb, Hrvatska

mr.sc ZLATKO SVIBEN. 
E-mail: zlatko.sviben@inet.hr
Poštanska i telekomunikacijska škola
Trg J. F. Kennedya 9, 10000 Zagreb, Hrvatska

ABSTRACT

The increase in the number of flights makes air traffic a serious problem of the present. Modern, jet aircraft generate deafening noise in the approach and takeoff of aircraft. Noise is generated by aircraft engines letting out at high speed vortex exhaust gases, and in case of supersonic aircraft there is additional thunder due to impact waves that follow takeoff or landing of aircraft. In order to solve the problem of aircraft noise, some alternative solutions will have to be implemented, such as replacement of the current air fleet by a new generation of aircraft or some immediate solutions such as the installation of hush-kits and some special parts in the aircraft, which also affects the reduction of aircraft noise. Fast development of airports, resulting in problems related to noise, require finding of ways in which to harmonize development, modernisation of air traffic and the "potential noisy adversaries" that occur as a consequence of the technological development of airports. It is interesting to know the values that define the noise as well as the values within which they range, according to the valid regulations. In this way other traffic participants can understand the environment and take the attitude of an active participant – define themselves to the measure of the human.

Key words: noise, ecology, aircraft, airport

1. INTRODUCTION - CURRENT CONDITION

Traffic degrades and devastates the environment and every project of traffic development either on land, in the air, or on water, needs to evaluate the volume of negative impact on the environment. The first knowledge about the harmful impact of traffic on the environment dates back to the sixties of the 20th century. Today, life would be unthinkable without the transport means, and yet their increase undoubtedly leads to the destruction of the natural flora and fauna. An important milestone in the development of air traffic is the introduction of the jet propulsion in the sixties. The main ecological criteria related to international commercial aviation include aircraft noise, aircraft engine emission, handling of waste material and pollution of soil and water at airports. At its 50th Assembly, IATA brought a Resolution on environment which fully supported the ICAO initiative about the revision of the restrictions in issuing the certificates which confirm that the airlines satisfy the criteria of noise, harmful exhaust emissions and chemicals, all with the aim of reducing the negative impact of air traffic on the environment. Adverse impact of anthropogenic polluters, including aircraft, affects to a great extent the global ecological balance in three main indications:

- change in the balance of earth radiation due to anthropogenic greenhouse effect, related to the change of global climate;
- change in the ozone in the atmosphere that affects the intensity of radiation on the earth surface;
- change in the oxidation capacity of atmosphere due to increase in the tropospheric concentration of ozone.

Regarding protection, today’s technology can respond to many requirements which first of all means the improvement of aircraft structure assemblies. The first aspect is the noise generated by aircraft, and the second aspect represents harmful emissions. The level of noise and the harmful exhaust emissions are regulated by the international (ICAO) and national regulations. The problems related to aircraft noise appeared when the number of operations during one day at one airport increased to such an extent that lives of the population living in the vicinity became intolerable. The introduction of jet aircraft resulted in protests of the population living around the airports due to noise. It was impossible to live, especially below the approach and takeoff paths. Noise is generated by aircraft engines which produce fast vortex exhaust gases. In case of supersonic aircraft there is also additional thunder due to impact waves which follow the takeoff or landing. When speaking of noise generated by aircraft we think of the subjective feeling that an observer on ground feels due to the aircraft-generated noise. For noise measuring, a large number of measuring units was defined and the most common is the decibel (dB).

Under the pressure of the public and the authorities, the airports have introduced additional measures to reduce the negative impact of noise on the environment: by restricting the
operations of noisy aircraft, by introducing certain procedures in approach and takeoff in order to reduce noise, by introducing approach–takeoff paths above less populated or unpopulated areas, by banning night air traffic at airports, by sound-insulation of houses i.e. buildings, by zoning of space, by moving.

1. the sum of EPNdBS for which the stipulated limits were exceeded, does not exceed the value of 4 EPNdB (for Chapter 2) i.e. 3 EPNdB (for Chapter 3 aircraft),
2. value of EPNdB, for which the noise is greater at any point, does not exceed 3 EPNdBS (for Chapter 2) i.e. 2 EPNdBS (for Chapter 3 aircraft),
3. the higher realized noise at one or two points is compensated by such reduction of noise in another or other points.

2. SOURCE OF AIRCRAFT NOISE

The basic source of aircraft noise is the power plant. Propeller aircraft generate significantly lower noise compared to others. Noise generated by an operating turbo jet power plant occurs in all the basic engine elements. Noise generated by fans and combustion spreads partially forwards and exits through the suction nozzle, and partly spreads backwards and leaves the engine through the fan nozzle. Noise generated in the combustion chamber exits through the central engine nozzle. Also the mixing of the ambient air with the jet of exhaust gases produces certain noise since they flow at very high speed. Fan in flight generates also additional source of noise, and this is noise that due to the interaction of fan blades and stator as well as the influence of their mutual location, wide range noise, that is generated under the influence of the conversion of work from the fan blades on the air flow with the aim of obtaining maximal effect of compression on a minimal space and whirling noise which results from supersonic speed of airflow at the fan blade tips.

The noise reduction can be influenced by using the material which absorbs sound into the engine flow channel, by mixing outside cold and interior warm flow of air or by installing hushkits at the exit of the central nozzle. The first reduction of noise occurred with the appearance of omni-flow turbo-jet power plants with low level of two-flow, and later with the occurrence of power plants with high level of two-flow.

Another element which causes noise is the planner. Noise generated by planner results from pulsing of aerodynamic forces on the wing, by the existence of turbulent boundary layer and vortex which occurs in air flowing around the surfaces of wings, fuselage and tail planes, as well as the airflow around landing gears, flaps and various other protrusions on the fuselage. During takeoff the level of noise caused by the planner is irrelevant, whereas noise generated in approach or landing is of great importance and regarding intensity can be compared to the noise of power plants. According to ICAO standards ANNEX 16 Chapter 2, the noise level of planner is stipulated at 8-10 EPNdB lower than the level of total noise, and in Chapter 3 the level has been stipulated at 5-7 EPNdB of the total noise intensity.
3. METHODS OF AIRCRAFT NOISE REDUCTION

There are two approaches in the global solving of the ecological problem of noise. The first one is technical, and it is related to hush-kitting the engine in exploitation. Hush kit is used as an addition to the final part of the jet engine and it allows conversion of aircraft into FAA Chapter 3 standard on noise reduction. These parts have to be resistant to very high temperatures, high vibrations and high pressure, as well as engine thrust.

Engines are hushed by replacing the engine and by replacing the noisy aircraft by new models. The other approach is the organisational-technological approach which includes regulation of the local traffic frequency and staying of aircraft in the air, as well as the rationalisation of the initial-final operations at airports. The most influential method of noise reduction is to reduce the source of noise, which means that “quieter” engines and aircraft have to be constructed. Introduction of the quiet fleet of Chapter 3 aircraft will greatly solve the problem of noise, thus allowing exploitation of airport at night, i.e. cancelling the night curfew. Regarding the hush kits, sets for aircraft modification are produces for the most numerous fleet of the Boeing 737-100 and 200 series aircraft, and the modification costs for one aircraft are 2.4 to 3.6 million US dollars. From the European carriers, only SAS included the modification sets for DC-9 aircraft along with ordering new Boeing 737-600 aircraft replacing MD-80 and F-28, and Lufthansa which already obtained the sets for the modification of the Boeing 737-200 fleet. These aircraft will be substituted in the further future by Airbus A-319. Aircraft manufactured in the East have the biggest problem with noise generation exceeding the permitted noise level. Therefore, their market price has fallen drastically. Such aircraft are used only in domestic traffic, whereas aircraft of western production are used for international traffic.

4. OPERATIVE PROCEDURES ALLOWING NOISE LEVEL REDUCTION

Procedure in takeoff – FAA procedure

In aircraft takeoff there is a procedure formulated by FAA and accepted by ICAO and one version of the procedure formulated by ICAO. According to the first procedure three segments are defined in takeoff, and within each the flight parameters are defined that reduce the noise level. The first segment applies the technique of aircraft climb which flies up to 1500 ft with the takeoff thrust thus achieving faster moving away from the ground and consequently shorter duration of noise on the ground. This procedure does not require installation of any new equipment, neither onboard aircraft nor on the ground.

Standard landing procedure

In landing i.e. approach, there is a larger number of procedures so that these can be compared with the standard procedure in approach. The standard procedure represents aircraft landing from the altitude of 1500 – 2000 ft above the airport of landing. In this flight the pilot receives first the signal of the marker bringing the aircraft to the runway axis i.e. line that matches the runway axis. Flying in that plane the pilot accepts the dive angle signal (which is at the angle of 3 degrees in relation to the horizontal plane point A), and then starts to dive. Flying at the dive angle the pilot brings the aircraft to the runway threshold to the altitude of 15 metres, and then starts landing. During the whole flight from the moment the pilot receives the marker signal, the aircraft is in the landing procedure (extended landing gear, 2 flaps extended, 3 flaps fully extended). For the normal flight performance (first in level flight, then in diving) the engine thrust must be increased in order to be equal to the total aircraft drag, and increased thrust generates a secondary phenomenon – greater noise generated by the engine itself.

Operative procedures used in order to reduce noise in landing are the following:

Increasing the altitude at which the dive angle signal is received

This is a procedure which is defined first since it is most widely used and does not require installation of any special equipment on any aircraft nor on the ground. Instead of flying the aircraft at level flight at the altitude of 450 to 600 metres (1500-2000 ft), in order to receive the dive angle signal, the pilot performs the level flight at the altitude of 900 metres until receiving the dive angle signal and then the aircraft dives towards the runway. Since the flight proceeds until reaching point A at a higher altitude than the flight in standard procedure, the noise level on the ground below the flight path will be lower. It should be emphasised that in both cases the flight is performed in the same configuration. According to this procedure the noise is reduced until arrival to point A after which the flight proceeds identical to the definitions of the standard procedure so that the noise in further flight is the same as in the standard procedure.
Approach in two stages

This procedure started to be developed in the USA, but for its implementation the aircraft needs to be fitted with the electronic equipment and additional devices need to be installed at the airport. The same as in the previous procedure, the aircraft flies horizontally at the altitude of 900 metres (3000 ft) up to point B where the pilot receives the special dive angle signal which is set at an angle of 6 degrees and then the aircraft dives at this angle all the way to point C at approximately 300 metres (1000 ft) of altitude, where the pilot detects the signal at the standard dive angle of 3 degrees, at which the final part of approach is performed and finally landing. This approach system has another drawback which is of operative nature. In previous practice the pilots landed so that they approached the runway at an angle of 3 degrees. In this procedure the pilots have to perform the first part of the approach at a double angle. Every pilot should attend additional training for such a steep approach.

Lufthansa procedure

The Lufthansa procedure is from the operative point very interesting since it does not require additional equipment neither onboard aircraft nor on the ground. The approach until detecting the dive angle signal is performed at the altitude of 900m (3000 ft) from the standard one, so that the noise generated by aircraft will be much lower until reaching the altitude of about 450 metres. Also, according to this procedure the noise will continue to be lower than in the standard procedure since the aircraft drag during flight with less extended flaps lower, so that this requires lower thrust in approach flight, which means also less noise. Since this is the case in which the aircraft stays longer in the configuration with lower drag in relation to the standard procedure, it is called the low drag – low pressure procedure. Finally, at 40 – 50 seconds prior to the landing itself, the landing gear is extended, bringing the aircraft to the final landing configuration. From that moment there is enough time for the pilot to balance the flight according to the dive angle path and to finally touch the ground. This procedure brings also certain saving of the consumed fuel which gives it additional significance.

Selective usage of runway

The purpose of selective usage of runways (at airports that have several runways) lies in the fact that, when possible, those runways are used that allow the aircraft in the initial takeoff phase i.e. in the final approach phase to avoid noise sensitive places. It is important that the selective usage of runways should not influence the flight safety so that this method is used if:

- the chosen runway is not clean nor dry (if covered by snow, ice, water or rubber scrap);
- the meteorological conditions are such that the cloud base is at the altitude lower than 150 metres above the runway selected for landing. Also, if the takeoff and landing conditions are such that the horizontal visibility is less than 1852 m (1NM);
- for the selected runway the lateral wind component together with wind gusts exceeds 29 km/h;
- for the selected runway the tail wind component together with wind gusts exceeds 9 km/h;
- “wind shear” is expected or bad weather which may affect the flight in approach or takeoff;
- the pilot thinks this may endanger the flight safety.

Approach / takeoff on curved path

The use of the Microwave Landing System (MLS) makes it possible to use in approach a curved path, and only finish the approach by flying at the level of the runway axis. If there is a settlement in line with the runway axis, it is possible to avoid flying over it and thus reduce the noise in that place. This procedure needs special electronic equipment onboard the aircraft and on the ground. The situation is similar if in takeoff,
instead of straight flight the turn is taken so that a settlement is avoided. This method reduces the noise in that place.

5. INTERNATIONAL REGULATIONS REGARDING AIRCRAFT NOISE

The restrictions to noisy aircraft started to be implemented on 1 April 1995. Then, the developed countries stipulated the penalty charge for noisy aircraft, and some were banned from operation. Regarding European airlines, they have to comply with the European Union directives, and they are the following:

- phasing out of Chapter 2 aircraft older than 25 years,
- replacement of Chapter 2 aircraft less than 25 years old,
- replacement of Chapter 2 aircraft, i.e. their modernization and adaptation to Chapter 3.

Approaches to solving this problem are different. In the USA, for instance, the carriers opt for hushing the existing aircraft, whereas the European carriers usually opt for the purchase of new aircraft, i.e. replacement of the entire fleet. The biggest problems occur in the states in Latin America, Africa and East Europe. These countries have mainly Chapter 2 aircraft, and some have still Chapter 1 aircraft. They cannot allocate the necessary means to replace the fleet, and at the same time they have to pay also the taxes to the developed countries so that their aircraft can land at their airports. If a certain airline faces a problem that their aircraft do not satisfy the basic standards related to the future, the airline has three possible options:

- phase out flying with that type of aircraft during the time when this is required by the regulations, and replace them by the new generation aircraft,
- perform stipulated and by adequate institutions certified engine modifications in order to reduce the noise they generate, and thus satisfy the set noise criteria,
- carry out the replacement of the existing engines that do not satisfy the stipulated criteria by new and advanced engines, if the manufacturers have foreseen that.

6. CURRENT SITUATION IN CROATIA

On 15 January 1992 the Republic of Croatia became an acknowledged member of the UN and therefore, ratified the Chicago Convention and all the respective legal documents. Within the Republic of Croatia, these regulations refer to the airlines Croatia Airlines, Air Adriatic, TradeAir – SunAdria, Dubrovnik Airlines. If we analysed the fleet of every airline, the Croatia Airlines fleet consists of 5 aircraft type Airbus 319, 4 aircraft Airbus 320 and 3 aircraft type ATR-42. Air Adriatic contains in its fleet 5 MD-82 and 2 MD-83 aircraft. TradeAir – SunAdria is an airline which operates in cargo and mail transport but in the mid-2005 it purchased 2 passenger aircraft type Fokker 100. Dubrovnik Airlines has in its fleet 2 DC-9 aircraft. Before the Airbus aircraft Croatia Airlines had used Boeing 737 aircraft. The reason for the change to the Airbus fleet is the penalty that has to be paid to other airports due to the noise produced by Boeing aircraft. Every year Croatia Airlines would pay about 1 million US dollars in order to cover the costs for the noise produced by Boeing aircraft that belonged to Chapter 2. The current Airbus fleet of Croatia Airlines belongs to Chapter 3 aircraft.

7. CONCLUSION

With the increase in the number of flights, air traffic is becoming a serious problem that needs to be solved at a global level. The solution for the noise of aircraft will have to find some alternative ways such as replacement of the current air fleet in Chapter 2 by a new generation of aircraft or some immediate solutions such as fitting of hush-kits and some special parts into the aircraft, which also results in the reduction of noise. One of the solutions that maybe proposed in the construction of approach and takeoff runways that are not above the trajectories of residential areas. Considering the future, this is a good solution, but taking into consideration the expansion of the urban areas, it is only a matter of time when the residential areas will again find themselves in the trajectory of approach and takeoff. While noise is one of the factors within a number of negative factors that are connected to air traffic, another negative factor should be mentioned, and that is the air pollution. Aircraft engines directly pollute the air in the region of ozone and the upper layer of the troposphere. In the areas of airports there is the highest concentration of pollution, so that it may be said that 45% of pollution can be accounted for by aircraft, and 45% by road traffic at and around the airport. Other polluters (medical waste, chemicals, etc.) are in a majority but they are not to be neglected. The pollution of underground waters and water supply areas of big cities and other residential areas would cause a catastrophe of unthinkable dimensions. The solution to the mentioned problem lies in the construction of airports outside the scope of the water supply areas and densely populated areas. Fast development of airports and the expansion of urban areas, resulting in big problems related to noise and air pollution, the human factor will have to find a way how to harmonize the development and modernization of air traffic and the "potential adversaries" who occur as the consequence of technological development of airports.

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