3rd Congress of the Alps Adria Acoustics Association
27–28 September 2007, Graz – Austria

INFLUENCE OF AIRCRAFT NOISE ON THE QUALITY OF LIVING NEAR THE AIRPORT

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Abstract: *With the increase in the number of flights and in accordance with the expansion of airports, air traffic is becoming a serious problem of the present times. In spite of the tendency to integrate maximally air traffic into all the ecological aspects, one of the main problems today is the noise generated by aircraft engines. These engines generate vortex, exhaust gases at high speeds, whereas in supersonic aircraft there is the additional thunder due to the impact waves produced during take-off and landing of the aircraft. It is important to know the magnitude that defines the noise, and the values within which they have to stay in order to comply with the valid regulations. The aircraft noise-related problems will have to be solved by certain alternatives, such as the replacement of the existing aircraft fleet by new generations of aircraft or by fitting the aircraft with hush-kits and other special parts. The solutions related to aircraft generated noise reduction can be sought also in the take-off and landing processes, navigation and adequate use of land, i.e. by creating non-populated green areas around the airports. This work deals with the impact and measuring of aircraft noise and detailed analyses of the results which may be used to determine the areas under the negative impact of noise. In this way, the endangering of the health of the population in these ecologically critical regions may be directly prevented.*

Key words: noise, ecology and the environment, airports, navigation, aircraft noise measurements

1. INTRODUCTION

Airport noise is generated by various operations of air and combined traffic. Apart from aircraft that are the main sources of noise, it is generated also by vehicles moving along the airport platform. The vehicle engine power is lower but, due to high concentration it may be considered continuous. Therefore, the expansion of cities and populated areas around the airports result in complaints about the noise in these regions. The complaints are mainly directed to aircraft noise which causes disturbances, sleeping problems and problems in communication. According to various studies, aircraft noise raises the level of stress, anxiety and generally has adverse impact on health. With the introduction of jet engines on commercial aircraft in 1960, noise has become one of the major problems. According to FAA (Federal Aviation Authorities) data [1], aircraft noise has risen seven times in the period since 1970. International noise level standards for certification of subsonic aircraft were first introduced by ICAO in 1969 and published in Volume I Annex 16 of Chicago Convention (International Civil Aviation Organization, ICAO) [2]. Chapter 2 standard was completed in 1976 when Chapter 3 was announced. Chapter 4 of the standard has been applied since 2001 to all types of aircraft manufactured after 2006. ICAO enabled adaptation to the standard for country depending on when it decides to start applying the Chapters on protection against noise, provided Chapter 2 is the initial one.

Since 1970 aircraft noise has been reduced by 75% but this process is still continuing with new projects dealing with further noise reduction, both from aircraft and other sources at airports. Noise around airports depends on several various factors and must be objectively measured, and defined. The measured data need to be put into a model which should be used to reduce noise. Airports, that still accept aircraft with the same level of noise, may charge penalties for exceeding the allowed levels. The charges need to be

based on aircraft noise certification issued according to the ICAO standards.
The development of technology has brought the design of new aircraft that are much quieter and the airport noise was significantly reduced. In order to avoid conflicts with the people living around the airport, some of airports have adapted their master construction plans of and have directed the new runways outside the populated areas. Apart from substantial costs for the construction and maintenance of infrastructure, incident situations and high social price, there is significant responsibility for the psychological and medical condition of the population as the result of pollution of air, underground water and soil, consumption of energy and natural resources.
The effect if aircraft noise may be classified into two categories. The first category is the impact of noise on the behaviour of people, and the other is the impact of noise on the medical and psychological condition of people. The effect which refers to the behaviour of people can be observed in their mental activity, relaxation and communication. The medical effect can be reflected in the damaged or total loss of hearing, increased blood pressure or increased stress hormone secretion.

2. SOURCES OF NOISE AT AIRPORTS

Zagreb Airport region may be divided into two main parts regarding noise sources. The first is the airside which, in a wider sense, encompasses the terminal air space and airport surfaces such as the runways, taxiways, apron, etc. There, the main noise sources are aircraft, handling vehicles and infrastructure facilities that produce a certain levels of noise. The other part is the landside, which encompasses terminal building, cargo building, roads and parking lots, as well as other buildings and areas, and in a wider perspective also the links to the city and the airport serving area. The main noise sources on the landside are the vehicles which operate inside the airport zone for the arrival, stay and departure of passengers, visitors and airport staff. [3]
There are two basic sources of airport noise: noise generated by flight operations and noise generated by ground operations. In both cases the field of noise around aircraft can be calculated if the data are fully available and regarding the engine power and sound propagation through the atmosphere for a certain area around the airfield. In order to calculate the contribution of the aircraft noise it is necessary to determine the source of total airport noise, whereas standard meteorological conditions can be assumed. The noise field from aircraft on the ground (engine running prior to take-off or engine running during maintenance) can be calculated. Depending on the type of operation (e.g. fix position for aircraft engine operation) for a sample of a certain source, one can assume that the noise is oriented in a specific direction. For aircraft take-off or landing, the noise at ever point of its flight has to be specially considered. A large amount of information is necessary to calculate the noise that results from many sources of the airport, including operative data such as time, soil type, and flight operation, engine power, data on atmospheric dampening and usage of the runway by operative airport data.

2.1 Aircraft noise

Aircraft noise can be defined as an undesired sound generated by aircraft. The main measure used in measuring the aircraft noise is the Equivalent Continuous Sound Level (Leq dB). This average is the sound energy controlled from all the measured aircraft events over a time of 16 hours. Small indications of disturbing the population can be registered at Leq = 57 dB, medium at Leq = 63 dB, and high at Leq = 69 dB. Bans because of noise at some airports have been implemented through bans on aircraft landing and take-off operations, curfews and flying over the houses. Studies have shown that the quality of sleeping can be disturbed by a relatively low level of noise, Leq of only 30dB.
Aircraft-generated noise can be divided into three groups. The first group contains noise generated by the aircraft power plants, the second interaction between the engine and the aircraft structure, and the third structure (form) of the aircraft. Considered regarding the type of operations, noise can be divided into noise generated during take-off and landing, and aircraft noise on the ground, i.e. during maintenance and testing of engines. Every mentioned source of noise contains also its subgroups and when they act as a whole they form the overall aircraft noise. There are two main certificates related to aircraft noise:

- FAR Part 368
- ICAO Annex 16.9.

These certificates require that the Effective Perceived Noise Level, (EPNL) be less than the maximum level permitted for every location. For the purpose of standardisation of measuring the intensity of noise in aircraft certification, ICAO has stipulated standard conditions and reference points (locations) in the vicinity of runways that determine the noise level in landing and take-off operations. These points are:

1. Take-off point (point A) – point which is located on the runway axis and 6500 metres away from the runway threshold. At this point the noise intensity in the take-off phase is measured;
2. Approach point (point B) – point that is located on the runway axis and 2000 metres away from the runway threshold. At this point the noise intensity in the landing phase is measured;
3. Lateral point (point C) – point that is located at the lateral distance of 650 metres from the runway. At this point also the noise intensity in the take-off phase is measured.

Maximum noise levels vary depending on the Aircraft Maximum Take-off Weight (MTOW). During acceleration on the ground and the take-off phase the dominant source of noise is the power plant. The usage of new turbofan engines and achievements in the engine development technologies, engine noise and the noise generated due to the structure of aircraft have been reduced to equal levels.

2.2 Aircraft noise in take-off and landing operations

In every aircraft there is the difference in generating noise at the moment of take-off and landing. In take-off the usual source of noise is the noise that is generated by the combination of thrust air, and the noise of the blades and combustion chamber, whereas in landing the main sources of noise are the noise from the turbine, blades, and the noise of the structure that is the result of drag.

In take-off itself, the level of noise caused by the aerofoil is unimportant, whereas the noise caused in approach or landing is of great importance and regarding intensity it can be compared with the power plant noise. Regarding the power plant, it has been proven that aircraft with propeller propulsion create significantly lower level of noise compared to others. Noise generated by the power plants of piston and turbo-propeller aircraft is negligible, and in this case the main source of noise is the propeller itself.

According to ICAO standards, ANNEX 16 Chapter 2, the level of aerofoil noise is regulated from 8-10 EPNdB lower than the level of overall noise, and in Chapter 3 the level is stipulated at 5-7 EPNdB out of the overall noise intensity. Structural noise on the aircraft is generally related to discrete frequency components. Because of the negative impact of aircraft noise, aircraft design, that would create least noise because of its structure, is becoming a growing challenge for aircraft designers.

The structure noise consists of the landing gear, ailerons, flaps, moving wing surface, and aircraft vertical stabilizer. Noise generated by flaps is caused by the external flap edges and their lateral edges. The vortex which occurs between the open and closed flaps is the main cause of creating noise around the lateral part of the flaps. This results in the turbulence and pressure flow which increases the aircraft noise.

One of the sources of structure noise is also the landing gear. This is caused by the airflow which streams around it. The landing gear has many curves and sudden transitions which additionally increase the complexity of the airflow, thus generating vortex, which increases noise. It consists of the nose and main undercarriage. Parts of the nose undercarriage, that most influence the generation of noise, are the fairing after retracting the wheels, main leg, struts, axle, wheels and brakes. The complex surface which is under the influence of pressure is located also on the rear undercarriage and on the diagonal strut. Every part on the landing gear creates a certain irregularity in the airflow, thus creating noise source.

Measurements have shown that the intensity of noise that was created by flaps, ailerons and the landing gear depend on the aircraft. This has proven that control surfaces used in take-off and landing phases produce less noise in case of smaller and mid-size aircraft, i.e. greater noise in the majority of aircraft. Whereas the control surfaces on the wings are the main sources of noise on mid-size aircraft, the landing gear has become the main source of noise on heavy aircraft.

3. Ldn and Lden

Lden is the calculation of Leq (equivalent) over 24 hours. At the beginning the symbol was Ldn (Day/Night Sound Level) because 24 hours in a day were divided into the period of day, from 7:00 to 22:00 hours, during which the noise level that was measured was equal, and the period of night, from 22:00 to 7:00 in the morning. Since the background noise was much lower during the night period, and according to research the human sensitivity during that period is much higher regarding sleeping, a certain value in dB was added as the corrective factor (CF).

The new value used by more and more airports in their measurements is Lden (Day/Evening/Night Sound Level). It is similar to Ldn, but because of the measurement precision and sensitivity of population living around the airport, new evening period has been introduced. In Lden there are three periods of observation: day from 7:00 to 19:00 where CF is not added, evening from 19:00 to 22:00 where CF of 5dB is added, and night in the duration from 22:00 to 7:00 and the additional CF of 10dB. Lden is the main measurement which is used to make the noise map. Corrective factors and times for certain values are presented in Table 1.

24 hour values	Single event value	Time		CF value (weight)
Ldn	SEL	Day	7:00 – 22:00	0 dB
		Night	22:00 – 7:00	10 dB
Lden	SEL	Day	7:00 – 19:00	0 dB
		Evening	19:00 – 22:00	5 dB
		Night	22:00 – 7:00	10 dB

Table 1: Times and corrective factors for airport noise mapping

3.1. Introduction of time restrictions at airports

Every airport has strictly defined time limit from when and until when the aircraft are allowed to fly, and upper margins of permitted noise. At the beginning, these restrictions were directed to general conditions and the level of airport service, and were fulfilled only if this was in the interest of the airport. At present, the aircraft noise measurement and the introduction of restrictions belong to the component of the airport operation. Furthermore, more developed countries have introduced "curfews" which reduce or eliminate noisy operations during late night hours, when people are most sensitive to noise. Such restrictions may have high Ldn since 10dB of CF are added to the main value. These restrictions are between 22:00 and 07:00 hours during Ldn. The simplest solution for airlines in preventing noisy operations is not to fly to those countries which impose restrictions on aircraft noise. The world-known airports have introduced restrictions in such a way that the changes of fleet for arrival to those airports or tax paying due to noise are inevitable. Taxes increase with the time period by adding value, as presented in Table 1. The result is that the same aircraft pays much more for the night landing, and the majority of airlines decide to perform daily operations only.

4. NOISE REDUCTION AT AIRPORTS

Apart from physical insulation and barriers, noise reduction at airports can be achieved also by operative measures in landing and take-off, i.e. by avoiding populated areas during these operations.

4.1 Isolating noise propagation by means of insulation and physical sound barriers

Sound barriers provide the possibility of controlling the noise sources present on or near the ground such as take-off, landing, taxiing and engine starting operations, APU running etc. In order to be effective, the barriers have to break through the line between the sound source and the person or group of persons who are under the impact of noise. Maximum effect is achieved when the position of the barrier itself is closer to the observer or the source of noise. In aircraft take-off the effect of barriers is lost due to obvious reasons.
Barriers can be walls or soil deposits. A long building, e.g. terminal building, can serve as a barrier, too. In blocking the line of visibility of APU or low-positioned engine aircraft, such as Boeing 737, the barriers of normal height can be used. In case of aircraft with higher positioned engines, such as DC-10, the barriers located in order to prevent the visibility line reduce the noise by 5dB. If barriers against take-off noise are set on the runway, it is best to set them directly along the objects that have to be protected against increased noise. Every barrier must be tested to all atmospheric conditions, and has to be well fixed in order to avoid collapsing due to extremely strong winds.

Land usage	Annual average day-night noise level (Leq) in dB					
	below 65	65-70	70-75	75-80	80-85	above 85
Schools	✓	× (1)	× (1)	×	×	×
Hospitals	✓	x	x	×	×	×
Churches, concert halls	✓	x	x	×	×	×
State offices, government	✓	✓	x	x	×	×
Transport means	✓	✓	✓(2)	✓(3)	✓(4)	✓(4)
Parking lots	✓	✓	✓(2)	✓(3)	✓(4)	×

Table 2. Balance of land usage with average level of sound day-night [4]

(1) When the society decides external or internal measurements in settlements or schools have to be performed to check the noise level.
(2) Noise measurement and reduction of 25dB has to be included in object design
(3) Noise measurement and reduction of 30dB has to be included in object design
(4) Noise measurement and reduction of 35dB has to be included in object design
(x) Land use and related structures generally compatible; measures to achieve NLR of 25, 30, or 35 dB must be incorporated into design and construction of structures.

Buildings in the vicinity of airports should be insulated, which is especially true for schools, hospitals, and other public institutions (Table 2). If properly insulated, the sound within the object should be 45dB with possible deviations of +/-5dB. Multi-layer windows against noise are recommended. Air-conditioning devices are ideal for summer days since opening of windows in the vicinity of airports may cancel the effect of insulation. Correct insulation can reduce aircraft noise by as much as 30 dB.

4.2 Operative measures of take-off procedures according to ICAO in order to reduce noise

The operative measures proposed by ICAO for the reduction of aircraft noise, consist of three segments. The first segment uses the standard take-off thrust, the speed is v_R + 19 -37 km/h, and the flaps are in take-off position. The first segment is followed by thrust reduction. The second segment uses the climbing thrust (for aircraft that have slower flaps retraction, the thrust should be reduced to the value which is necessary for flight with flaps in intermediate position), speed in the first part of the second segment is increased until the flaps are at zero degree and in the take-off position.

Regarding the very thrust reduction, the noise is automatically reduced by this phenomenon.

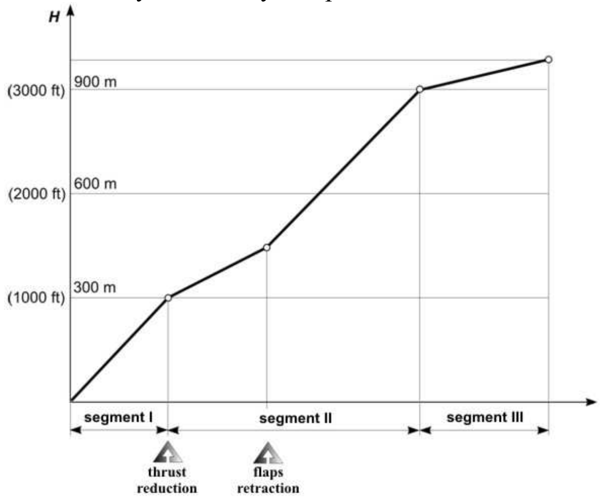

Figure 1. Three take-off segments defined by ICAO

The change in take-off angle, i.e. take-off segments that are at smaller angle result in lower direction of nozzles towards the ground, and thus reduction of noise on the ground. In the third segment the climbing thrust is used, speed is increased to 465 km/h and maintained from 3000 ft. In this segment the flaps are retracted. Above 3000 ft it is assumed that the aircraft is already at the altitude at which its noise has no significant impact on the population on the ground.

4.3 Standard landing procedure

Standard landing procedure represents aircraft landing from the altitude of 1500 – 2000ft above the airport of landing. In this flight the pilot receives first the marker signal bringing the aircraft to the runway axis, i.e. the 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), 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 entire flight from the moment the pilot receives the marker signal, the aircraft is in the landing procedure (extended landing gear, flaps extended, flaps fully extended). For the normal flight performance (first in level flight, and then in diving), the engine thrust must be increased in order to be equal to the total aircraft drag, and the increased thrust generates a secondary phenomenon – greater noise generated by the engine itself.

5. MODELS OF IMPLEMENTING OPERATIVE MEASURES TO REDUCE NOISE AT ZAGREB AIRPORT

Apart from standard procedures, there are several models of operative measures which might reduce the noise at Zagreb Airport [5].

5.1 Increasing the altitude at which the diving starts

This is the most widely used procedure and does not require installation of any special equipment onboard the aircraft or on the ground. Instead of flying the aircraft at level flight at the altitude of 450 to 600 metres (1500-2000ft), in order to receive the dive angle signal, the level flight is performed at the altitude of 900 metres, until receiving the dive angle signal, and then the aircraft dives towards the runway. Since the flight proceeds 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 the point of starting the dive, 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.

5.2 Lufthansa procedure

The Lufthansa procedure 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) as in the standard procedure, but the flaps are gradually extended. In this way the noise is lower since the aircraft drag in flying with less extended flaps is lower. This requires lower thrust in approach flight which means less noise. In this case the aircraft stays longer in the configuration with lower drag and therefore this procedure is called the low drag – low pressure procedure. At 450m (1500ft) of altitude, the landing gear is extended, and at 220m (700ft) full flaps are extended. This brings the aircraft into final configuration for landing, and the noise is equal to the noise of standard procedure. 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. Apart from noise reduction this procedure brings also certain saving of the fuel.

5.3 Approach in two stages

For its implementation the aircraft needs to be fitted with the electronic equipment and additional devices need to be installed at the airport. The aircraft flies horizontally at the altitude of 900 metres (3000ft) up to a point 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 approximately 300 metres (1000ft) 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. Whereas in previous practice the pilots landed so that they approached the runway at an angle of 3 degrees, in this procedure they have to perform the first part of the approach at a double angle. This method of landing requires additional pilot training, but due to longer stay of the aircraft at a higher altitude, the noise directly below the aircraft remains at the same level. Noise begins to increase in close vicinity of the airport at a distance of about 11.6km when the aircraft starts diving, and becomes equal to the noise of the standard procedure at about 300m of altitude, i.e. at about 6.5km from the runway threshold.

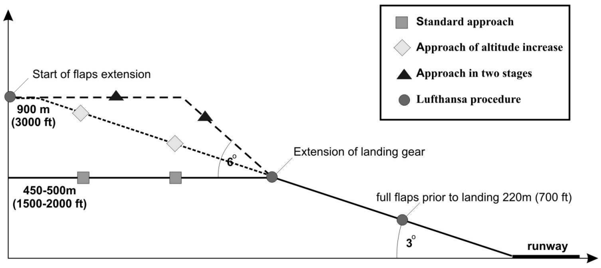

Figure 2. Models of landing procedures applicable at Zagreb Airport

5.4 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 take-off, instead of straight flight the turn is taken so that the settlement is avoided. This method reduces the noise in that place.

5.5 Reduction and control of aircraft noise in ground operations

Noise generated in ground operations refers to the noise generated by aircraft origin that is produced in aircraft handling, maintenance and during its overhaul. Although this type of noise is controlled in order to eliminate complaints of the people living in the vicinity, usually additional measures are undertaken for its control which is the main prevention compared to personnel safety. Often the reduction of noise of 10dB or more in certain areas in the vicinity of airports can be achieved by correct usage of certain samples of various noise sources. Moving of aircraft engine testing to areas further away from airports, and usage of any special meteorological or terrain circumstance as well as other alternatives may be of crucial importance. A certain time period is also suitable for sound propagation. The maintenance operations should be avoided at night when people are sleeping. If aircraft run in the vicinity of hangars or buildings, the effect of being sheltered by the hangar may reduce the noise level near the hangar from 10 to 25dB. The most efficient method of noise reduction in maintaining the operation of jet aircraft engine is by using the hush kits thus providing noise reduction from 10 to 25 dB.

6. INFLUENCE OF AIRCRAFT NOISE ON THE PSYCHOLOGICAL AND MEDICAL CONDITION OF POPULATION

Based on the research carried out in Germany [6], in the close vicinity of the Munich Airport, the results were worrying regarding the issue of the impact of noise on the human organism. The research included 217 schoolchildren from the rural areas in the vicinity of the airport before and after its opening. About half of the children living directly beneath the approach i.e. take-off plane of the international airport have been compared to the children of similar sociological conditions living in much quieter areas. The children had their blood pressure measured as well as the stress hormones, six months before the airport was open to traffic, as well as six, i.e. eighteen months after the airport started operating. In case of children living in the noisier area a moderate, but characteristic rise of blood pressure was noticed as well as a significant rise in the stress hormone, whereas in case of children living in quieter areas no significant changes were noticed. Eighteen months after the airport was open to traffic, a report was made about a significant decline in the quality of living of the children in the noisy zone.

Every noise exceeding the noise of normal speech can damage the parts of the ear cochlea which converts sound signals into auditory signals of the nervous system. The primary damage of the cochlea can be only momentary, but further exposure to noise results in the permanent damage and there may be tinnitus as well.

The hearing of humans can be damaged because of exposure to especially strong and long-acting noise, and it depends on the frequency i.e. tone level with high tones damaging the hearing more than the lower ones. Strong impact of noise strains the internal ear, which is reflected in temporary shift of hearing threshold. After the noise is reduced and after longer period of rest, hearing threshold also returns to the original condition. For instance, workers that start their work in a noisy environment will restore their hearing until the beginning of the next shift. With every exposure to noise, the hearing organs are burdened and strained. The repeated shift in the hearing threshold after the shift has ended is recovering gradually, which takes hours, but this recovery is only partly. Periodic hearing strain during one shift permanently reduce the capability of receiving sound signal and speech, which increases the probability of incidents, which also includes the change in behaviour both in the social environment and outside the workplace. With every repetition of noise exposure, the ear loses its capability of recovering the hearing threshold. If temporary hearing threshold shifts and excessive strain of the ear follows, permanent loss of hearing or damage of the hearing organs can occur. These consequences are caused by the damaging of the ciliary cells in internal ear, which cannot be replaces nor healed.

Permanent hearing loss is caused by permanently repeated exposure to noise or individual cases due to short exposures to high-level noise which is possible in air traffic. Hearing loss in humans occurs gradually and at first involves high tones, i.e. upper frequency spectrum. A person with hearing damaged in this way, still hears most of sounds but the hearing of speech is unclear and distorted. If such a person is in a room with high level of noise, in which several persons are talking, they will hear a part of background noise, i.e. ambient noise and only parts of the conversations which will seem distorted. Possible solutions are hearing aids, but they do not entirely solve the problem, since they make the speech louder but not more understandable and therefore fail to be satisfactory therapeutic means.

Noise does not only damage the hearing but also increases the probability of incidents. Straining the organism by noise may cause functional disturbances of human body and its regulation systems, i.e. disturbances in orientation. Because of long exposure to noise, especially with additional strain due to vibrations, work in shifts, heat, harmful materials, the entire human health is jeopardized, especially the heart and blood circulation. One of the consequences of noise on the human body is accelerated pulse and increase in blood pressure, as well as narrowing of blood vessels. After a longer period of time such symptoms may additionally strain the heart. Due to longer exposure to noise there is increased secretion of hormones and muscle convulsions. One of the results of excessive exposure to noise is also nervousness, insomnia, and fatigue, which primarily endanger the safety at work and work performance.

The problem that occurs with high noise in speech is intonation. Noise generated by aircraft in the vicinity is greater than the speech between two people and there is interference in communication. This results in emphasising and loss of certain words in the conversation. At 85dB the listeners hears 95% of words, and the remaining 5% are lost. Normal conversation can be led at 65 dB.

7. CONCLUSION

Aircraft is the main source of noise that influences people within a certain radius around this source, as well as the crew and passengers onboard. Aircraft noise can be solved by replacing the current fleet which is in category 2 by a new generation of aircraft or by solutions such as installing hush-kits. One of the solutions is in the long-term planning of airports, i.e. building of runways that are not on the routes of populated areas. With the development of airports and expansion of urban areas, which result in big problems related to noise and air pollution, human factor will have to find a way how to harmonise development and modernisation of air traffic and the “potential enemies” that occur as the consequence of technological development of airports. In air traffic, as in other branches of traffic, the priority lies in the safety of passengers, crew and the transport means, the aircraft. The latter refers to the technical characteristics of aircraft and people who are exposed to constant impact of aircraft noise.

There are certain limits when noise could be prevented but the safety standards do not allow it. In such situations noise reduction is neglected and everything is focused on the flying safety. Safety requirements during take-off procedure mostly refer to the reduction of engine power. Noise reduction can be achieved also by operative measures in landing both by purchasing additional equipment onboard aircraft and at airports, and by higher investments.

ACKNOWLEDGMENTS: This study is a part of the project No. 135-1352339-2349 supported by the Ministry of Science, Education and Sports of the Republic of Croatia.

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