Noise Pollution around the Airport with Noise Exposure Forecasting Modeling

Ali Mansour Khaki[*], Amir Esmael Forouhid[**]

[*] Professor of Civil Department, School of Civil Engineering, Iran University of Science & Technology, Narmak, Tehran, Iran.
[**] Phd student, Road & Transportation Engineering, School of Civil Engineering , Iran University of Science & Technology, Narmak, Tehran, Iran.

Abstract- The operation of airports results in environmental impacts associated with high levels of different noise. These may have severe and negative effects on surrounding residents. Aircraft noise is a significant and critical component of the aviation global economic infrastructure. If there is to be growth in aviation, the environmental impacts of aviation must be mitigated. In this paper, a model for the noise pollution of IKIA has been calibrated with the use of noise forecasting software. The calculated model is based on operations and flight data recorded by the airport. The flight data include the type and number of aircrafts, number of runways, etc. which depend on day-time and night- time operations. The results of this model explain the land use of airport and finally explain some methods for decreasing the effects of noise pollution of airport like enforcement of appropriate environmental regulations on the airliners.

Index Terms- airport, noise, pollution, modeling.

I. INTRODUCTION

THe method commonly used to quantify environmental sounds consists of evaluating all the frequencies of a sound in accordance with a weighing that reflects the facts that human hearing is less sensitive at low frequencies and extremely high frequencies than in the mid-range frequencies. This is called “A” weighing, and the decibel level measured is called the A-weighted sound level (dBA).

The Federal Aviation Administration (FAA) requires that environmental documents address noise impact around airports using an impact threshold of Day Night Average Sound Level (DNL) 65dBa. The problem of noise around airports is that it has a history almost as long as that of aviation itself. As the number of planes increased, so did the noise, and so did the number of complaints [1]. Public pressure led to the introduction of many different types of constraints at an increasing number of airports in an effort to keep both annoyance and complaints to a minimum. Noise pollution surrounding the IKIA airport is a growing concern in Tehran. This includes regions such as those near this airport where development is occurring. The FAA has identified the effects of noise pollution on populations in areas surrounding airports as an issue that needs consideration. Studies that assess noise impact demonstrate its adverse impact on affected areas [1]. The FAA has developed mapping methods with software that produce noise contours of varying magnitude around aircraft sources. This study intends to answer the following research question: What are the dimensions and magnitude of noise levels of the current footprint of noise pollution around the IKIA airport. To answer this question, use noise exposure software for estimating the noise of aircraft near the airport.

II. AIRPORT NOISE MODELING

The computer simulation of the noise exposure level that use at IKIA airport and its surrounding areas is conducted using the noise exposure forecasting(NEF) modeling, The noise exposure forecasting modeling, as used in the current study, computes noise exposure levels. The noise metric computed by the model is the annual average Day–Night Sound Level. The widely-used DNL metric is known to be highly correlated with community annoyance and is associated with a variety of land use guidelines that suggest where incompatibilities are expected to exist between the noise environments and various human activities. Data input to the NEF includes runway coordinates, flight tracks, flight operations and types of aircraft. NEF computes the overall noise exposure at points on the ground around the airport. Data was modeled for a period between March 2010 to March 2011. The use of NEF in computer-based noise modeling not only gives the noise exposure levels based on the current flight operations, but also allows for the prediction of future noise levels due to a projected increase in flight operations. This is especially useful for a rapidly growing city like Tehran and IKIA airport.

III. IKIA AIRPORT SPECIFICATION

Imam Khomeini International Airport is located 40km in the southwest of Tehran (Figure1). Being the airport of the capital is a huge advantage in the sense that Tehran is a leader city in its country in terms of economics, industries, culture, and that Tehran is also the most populated Iranian city.

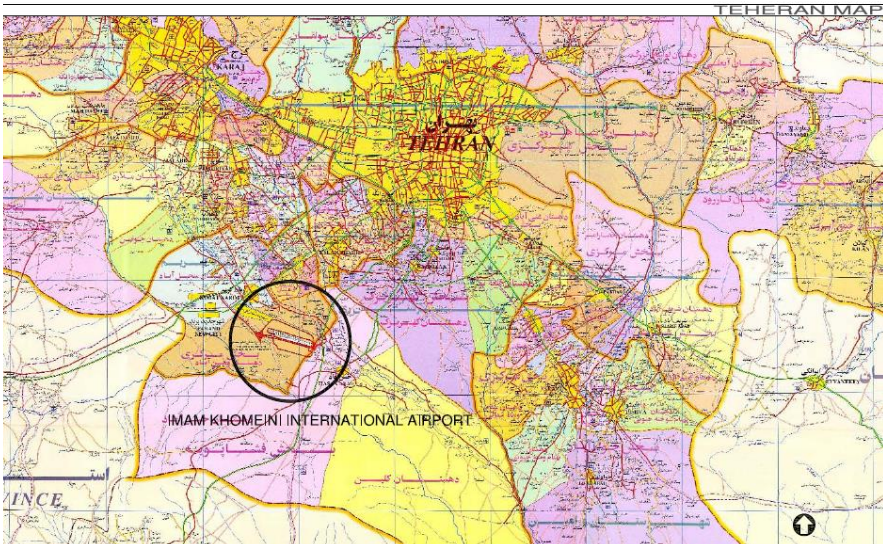

Figure 1: Imam Khomeini International Airport Site in the map [6]

Moreover, Tehran offers numerous possibilities to reach other major Iranian provincial towns thanks to a developed road network, rail network, and domestic air traffic network.

The total airport site is about 13500 Ha and it is divided in two parts, a northern one and a southern one, separated by an important spine road connected to Tehran. Figure 2 shows the whole region of IKIA airport. Today, only the northern site of the airport is developed but it already represents about 1400 Ha. The large wide areas surrounding the airport offer an important development potential in order to turn IKIA into the main prestigious gateway of Iran.

Figure 2: The whole region of IKIA Airport [6]

Next section describes the methodology used for creating the noise exposure map.

The data and assumptions used for leading such a study are presented and detailed below.

Data summary:

• Distance to city center : 40 km
• Airport site area: 13500 Ha
• Airport reference point coordinates:
- Latitude: 35 24 58 N;
- Longitude: 051 09 08 E;
- Elevation: 1007 meters.

Specifications for all planned runways are summed up below:

- Length of scheduled runways is 4200 m;
- Width of runways is 60 m with 15 m shoulders;
- Distance between parallel runways will be 400 m;

IV. NOISE MODELING METHODOLOGY

The contours are calculated by the combination of noise from many individual aircraft movements. All types of aircraft and operations are taken into account including their specific noise and performance characteristics. The NEF model generates the noise exposure level by computing the sound energy from individual events over an array of grid points around the airport.

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The process of generating noise exposure contours is therefore calculated by summing up the noise level at each grid location depending on the airport characteristics, aircraft operations by aircraft type and engine thrust level along each flight track. The cumulative noise exposure levels at all grid points are then used to develop noise exposure contours for selected noise metric values.

The noise impact study was conducted in several steps:

- summarizing the airport characteristics
  Select the aircrafts that are used in airport.
- defining the typical flight tracks for each time frame.
- computing the day and night events per runway and flight tracks.
- running and calculating the Noise Exposure Forecasting to produce the selected noise exposure contour sets.

V. AIRPORT OPERATIONS

A split between day and night operations was computed based on the data provided by IKIA airport authority [6]. By this data can divide all the flights with the type of the aircraft. In Table 1 percentage of the aircraft usage is shown.

Table 1: Percentage of the aircrafts usage in the airport

Aircraft type	**Internal usage (percent)**	**International usage (percent)**
Fokker 100	47	3
Boeing 727	12	
M-D 80	3	
ATR 42 – 72	5	
Airbus 300	1	10
Airbus 318/319/320/321	7	34
Airbus310		
Airbus 330	12	20
Boing 747		6
Tupolof 154	25	5
Boing 737		12
Airbus 340		10

VI. AIRPORT CHARACTERISTIC

In Table 2, the percentage of runway usage is shown. Only one runway is used for takeoff and landing operations for the airport.

Table 2: Percentage of the runways usage in the airport

Runway	**Usage of the runway for takeoff and landing (percent)**
11R	-
29L	-
11L	40
29R	60

As a consequence of the standard wind orientation, most of the operations happen on the 29R runway (from East towards West). In Figure 3, tracks for the aircraft on the runway are shown. The ICAO also provides a standard departure charts instrument. In Figure 4 the sample charts for takeoff and landing that were used for the analyzing in the software are shown. These charts were created using the Microsoft Excel. A sample of the excel sheet is shown in Table 3.

According to IKIA existing Airport Information Publication (AIP), the procedures for outbound aircraft are mainly concentrated on seven radials originating from IMAM KHOMAINI VOR/DME or destination to KAHRIZAK NDB. These exit radials were used to model the flight tracks followed by the various aircraft that will be accommodated at IKIA Straight-in approaches were assumed on each runway.

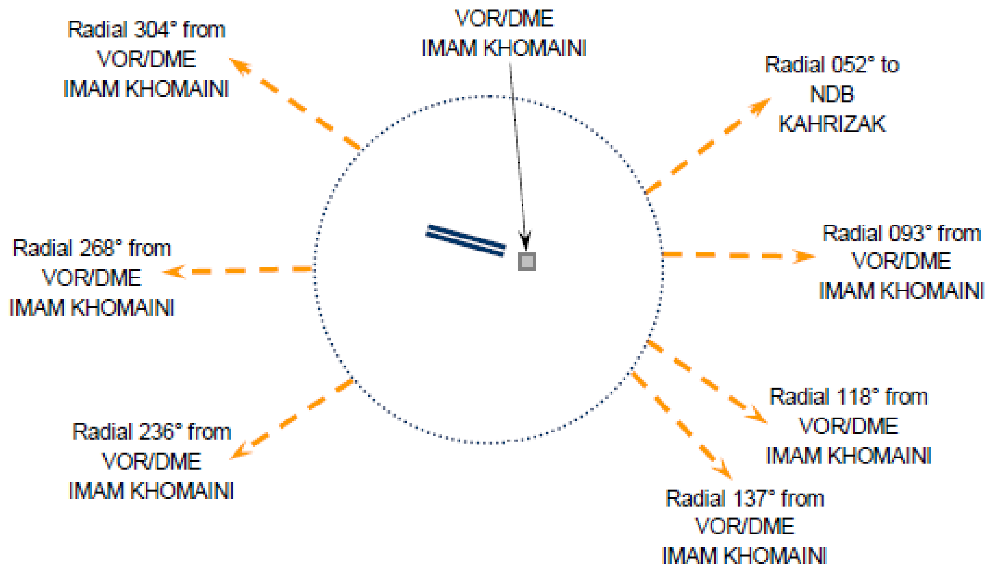

Figure 3: Tracks for the aircraft on the runway

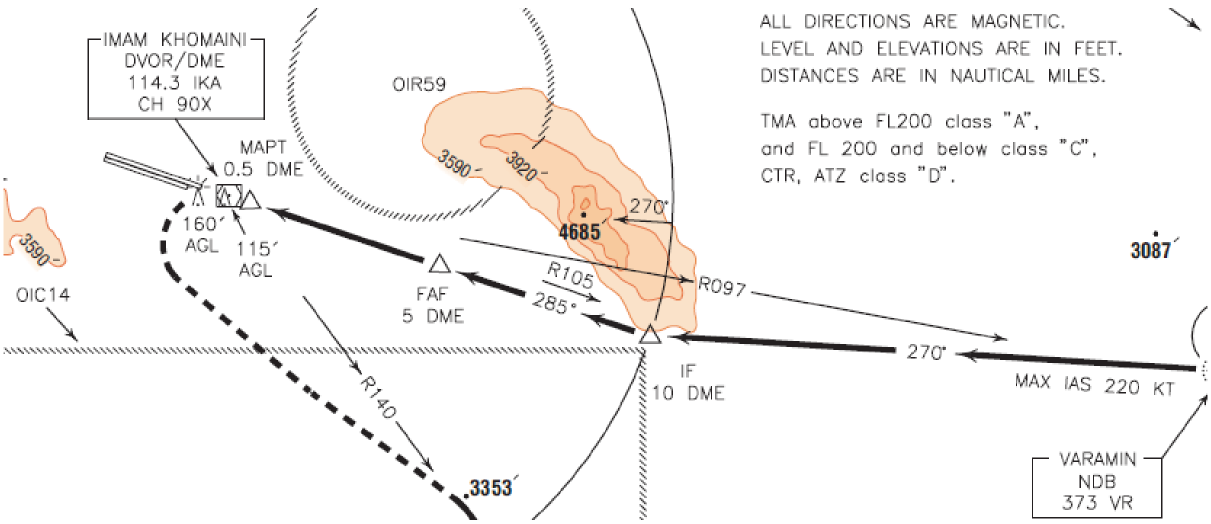

Figure 4: Sample chart for Approach in the runway

Table 3: Sample of Excel sheet for aircraft tracks

TYPE	DEP/DEST	SID	RUNWAY	ANGLE
T154	Adnan Menderes Airport TURKEY	MIVAK	29 R	5
B742	Göteborg-Landvetter Airport SWEDEN	MIVAK	29 R	5
A310	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A310	Dubai International Airport EMIRATES	1 SAV1	29 R	54
B737	Urumqi Diwopu International Airport – Urumqi, Xinjiang CHINA	DEHNAMAK	29 R	198
A306	Paris Orly Airport FRANCE	MIVAK	29 R	5
A320	Dubai International Airport EMIRATES	1 SAV1	29 R	54
B722	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A306	Frankfurt International Airport GERMANY	MIVAK	29 R	5
A306	Paris Orly Airport FRANCE	MIVAK	29 R	5
A310	Birmingham International Airport – Birmingham, England	MIVAK	29 R	5
T154	Damascus International Airport SYRIA	PAVET	29 R	5
A343	Bahrain International Airport	1 SAV1	29 R	54
A306	Birmingham International Airport – Birmingham, England	MIVAK	29 R	5
T154	Damascus International Airport SYRIA	PAVET	29 R	5
MD11	Amsterdam Airport Schiphol – Haarlemmermeer, near Amsterdam	MIVAK	29 R	5
A306	Dubai International Airport EMIRATES	1 SAV1	29 R	54
T154	Damascus International Airport SYRIA	PAVET	29 R	5
B742	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A310	Birmingham International Airport – Birmingham, England	MIVAK	29 R	5
A310	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A306	Frankfurt International Airport GERMANY	MIVAK	29 R	5
A306	Hamburg Airport GERMANY	MIVAK	29 R	5
A320	Vienna International Airport AUSTRIA	MIVAK	29 R	5
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MD11	Amsterdam Airport Schiphol – Haarlemmermeer, near Amsterdam	MIVAK	29 R	5
A306	Frankfurt International Airport GERMANY	MIVAK	29 R	5
A310	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A306	Frankfurt International Airport GERMANY	MIVAK	29 R	5
A310	Dubai International Airport EMIRATES	1 SAV1	29 R	54
A306	Paris Orly Airport FRANCE	MIVAK	29 R	5
B742	Dubai International Airport EMIRATES	1 SAV1	29 R	54
T154	Damascus International Airport SYRIA	PAVET	29 R	5
A306	Birmingham International Airport – Birmingham, England	MIVAK	29 R	5
A310	Birmingham International Airport – Birmingham, England	MIVAK	29 R	5

VII. ANALYZING WITH NOISE EXPOSURE FORECASTING MODELING

This paper uses the noise exposure forecasting because its availability. The NEF consists of a map of the noise contours plotted over the airport layout at each time period. Noise contours for NEF 30, 35, 40 and 45 noise levels are shown on the map.

In this software, NEF+35=DECIBEL and for discussion, should change the numbers of NEF to decibels. In the chart below, define the steps for modeling the noise of the airport.

At the end by selecting the aircraft type and enter the data that was shown in the Excel format in the software, calculate and run the software. In Figure 5, import the contour in the Google Earth map.

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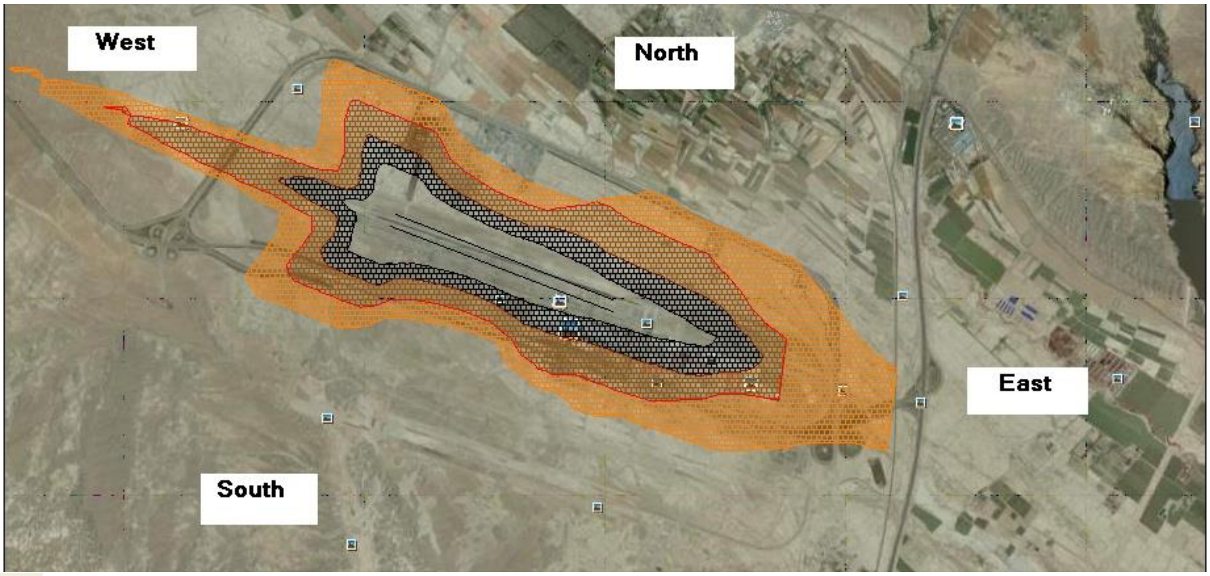

Figure 5: Contours of the noise around the airport

Invert the output of software to decibels:
Black contour: 80 decibels
Brown contour: 75 decibels
Red contour: 70 decibels
And at last contour 65 decibels.

In table 4, standard suggestion of the environmental organization of IRAN for noise is shown. By the results of the contour map and this table, divide four the regions and in figure 5 the result is shown.

Table 4: Standard for noise values [7]

Night (10pm-7am) Unit in decibels	Day (7am-10pm) Unit in decibels	Type of region
45	55	Residential region
50	60	Residential - commercial region
55	65	commercial region
60	70	Residential-industry region
65	75	industry region

With comparison to the noise map from the noise exposure forecast modeling with the ICAO land use recommendations in Table 4, and knowing that in the airport we also have noise pollution from numerous vehicles and factories that may develop in the near future, should have a master plan for decreasing the noise of the airport, should do it first at the origin of it and then by barriers with a suitable plan for building near IKIA. In the next section, suggest some recommendations that may be used for the airport.

VIII. LAND USE RECOMMENDATIONS

Land use management in the vicinity of IKIA is essential to avoid conflicts with existing and future surrounding communities as well as providing sufficient flexibility for the development of the airport. The International Organization for Standardization has established restrictive guidelines relating types of land use to airport sound level [8]. All land uses within the areas below 65 dB are considered to be compatible with airport operations. Residential land uses are generally incompatible with noise levels above 65dB. In some areas, residential land use may be permitted in the 65-70 dB with appropriate sound insulation measures implemented. Schools and other public facilities located between 65 and70 dB are generally incompatible without sound insulation. Above 75 dB, schools, hospitals, nursing homes and places of worship are considered to be incompatible land uses.

Land use management measures used include both preventive and corrective techniques. Preventive land use management techniques seek to prevent the introduction of additional noise sensitive land uses within existing and future airport noise contours. Corrective land use management techniques seek to remedy existing and projected future unavoidable noise impacts in existing areas of incompatible land use. The responsibility for determining the acceptable and permissible land uses and the relationship between specific properties and specific noise contours rests with the local authorities.

IX. SUGGESTION METHODS FOR CONTROLING NOISE IN THIS STUDY

The negative impact of aircraft noise, in particular around airports, is increasing. More and more people suffer not only from annoyance, but recent studies indicate that intermediate and high noise levels also contribute to physiological and psychological effects that in extreme cases can cause severe health problems. The aircraft industry has launched an ambitious plan for the next 15 years to reduce the noise emission levels from aircraft by as much as 20dB. Even if this goal can be reached, reduced noise emission levels for new aircraft will have little or no influence on the total noise situation around airports in future. This is due to a slow renewal rate for aircraft combined with an increase in passenger volume. In order to stay competitive and to cope with an increasing number of neighborhood complaints and noise-impact related constraints, airport owners will have to look for novel solutions to reduce noise emission levels. The International Civil Aviation Organization (ICAO) has defined a four-point "balanced approach" that includes:

Reduction of noise at source;

For improving this method airports authorities should develop and buy new aircrafts that have less noise such as boeing 757 instead of boeing 727 and etc.

Land-use planning;

For this method all the principals should be considered according to the contour map and the table above.

Noise-abatement operational procedures;

Noise is unwanted sound that is transmitted by vibration through air, walls, floors, or ceilings. In a home or office, there are three ways to control sound transmission _ Increase the mass of partitions _ Break the path of vibration and Cavity absorption. Increasing the mass of walls and other structures can present a problem in lightweight construction because the increased weight may not be structurally practical or aesthetically pleasing. It can also be more expensive.

X. CONCLUSION

The major innovation from the IKIA study is for noise management in the air-transport industry in TEHRAN - IRAN. The project addresses the new regulatory framework required to implement some approaches, and it addresses both the initial conditions and the sustaining parameters for this new paradigm. If successful, this new paradigm could assist in avoiding major environmental problems associated with growth in the air-transport industry, and assist in maintaining viability and vitality in this key sector of the European economy.

The IKIA study also is innovative in its approach to finding multi-dimensional solutions to this complex problem.

New ways of linking the disparate factors influencing behaviors of the air-transport players are also addressed. Airport fees can be linked to total noise impact; a combination of noise emission levels and number of people affected. By providing an economic incentive, airlines can be persuaded to choose low noise solutions in order to save operational costs. Such solutions may include changing to low noise emission aircraft, using low noise take-off and landing procedures within the constraints of the ATM, etc. A monitoring system may be implemented to yield accurate information about the actual per-event noise impact.
Hence, innovations from the IKIA study will contribute to:

Reducing the negative noise impact around airports including harmful health effects

Improving the community response to airport operations Improving the quality of life of its citizens.

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AUTHORS

First Author – Ali Mansour Khaki – Professor of Civil Department , School of Civil Engineering , Iran University of Science & Technology, Narmak, Tehran, Iran.

Second Author – Amir Esmael Forouhid (corresponding author) – Phd student, Road & Transportation Engineering, School of Civil Engineering , Iran University of Science & Technology, Narmak, Tehran, Iran.