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NOISE MONITORING BY LOCAL SELF-GOVERNING BODIES AROUND NEW TOKYO INTERNATIONAL AIRPORT

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1. INTRODUCTION

At the hill area between Narita and Shibayama in Chiba Prefecture, New Tokyo International Airport (Narita Airport) was opened in May 1978. The airport is situated 66km away from the central area of Tokyo and operated with only one 4000m long runaway now. About 340 aircrafts land and take off at the airport a day. As the airport is typical inland one, it is necessary to carry out airport noise monitoring.

We have been monitoring the airport noise from the beginning and improving its systems. Moreover these methods are applied to other airports such as Tokyo International Airport, Osaka International Airport and others.

We will describe the progress of monitoring systems and their future perspective.

2. AIM OF NOISE MONITORING

In Japan, WECPNL, simplified version of the international standard of ICAO, has been used for the evaluation of the aircraft noise and it is calculated by

$$WECPNL = \text{dB(A)} + 10\log_{10} N - 27 \qquad (1)$$

where dB(A) is the energy mean value of the maximum A-weigted sound pressure level with time-weightings and

$N = N_2 + 3N_3 + 10(N_1 + N_4)$

N_1 : Number of flights at $0:00 - 7:00$

N_2 : at $7:00 - 19:00$, N_3 : at $19:00 - 22:00$, N_4 : at $22:00 - 24:00$

The environmental quality standards for the airport noise are 70 WECPNL over residential area and 75 WECPNL over other area and are applied to each area except airport site or industrial area.

According to a state law at the first kind of area (over 75 WECPNL), a pecuniary aid to renew constructions for reducing noise, at the second (over 90 WECPNL), the aid for house removal and at the third (over 95 WECPNL), a construction of buffering areas such as green belts are in legal obligations.

The primary aim of the monitoring is to verify the achievment of the environmental quality standard and the secondary is to certificate the appropriateness of the area classification.

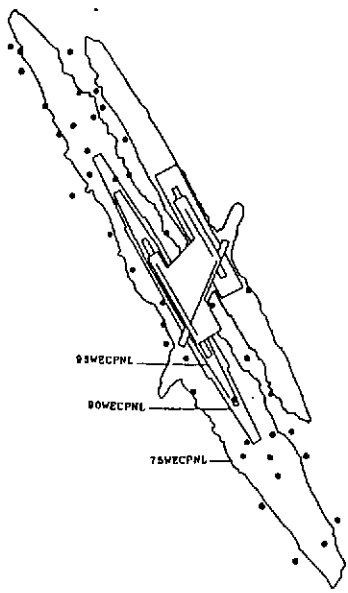

Fig.1. New Tokyo International Airport. Circles stands for measuring points.

3. HISTORY OF NOISE MONITORING

3.1 Sound Level Meter and Level Recorder (First Period)

To seize the distribution of noise level, the investigations were carried out several times a year. Measurements had been carried out at 50 points around the airport during 7 days (one week) continuously. At each measuring point, observers utilized sound level meters and level recorders and observed the flight paths with their eyes. These methods could monitor only within short period and needed expense and labors.

3.2 Automatic Measurement System(Second Period)

In order to measure noise level annually, we developed automatic measuring system in 1985. We developed the following system.

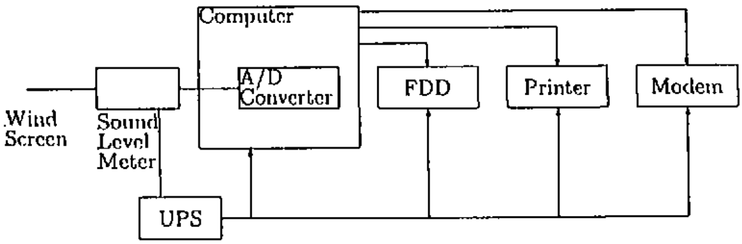

Fig2. Block diagram of noise monitoring system

In order to improve identification ability, the times of maximum level at several points were analysed. The identification rate became almost the same as manual method.

3.3 Improvement of Automatic System (Third Period)

In 1987, we developed the online systems for data aquisition and analysis. In that system each point is connected by public telephone network and measured data are transferred automatically at midnight. In 1987 we set equipments only at 6 points and now in 1996 on 55 points.

We concentrated our attention on a characteristic electro-magnetic wave, influenced little by meteorological conditions, emitted from aircrafts. The new system always receives a transponder signal (1090MHz) from aircraft and analyses its field strength. Considering two values, sound pressure level and electro-magnetic field strength, our system identify the aircraft noise. The identifcation rate is over 98% irrespective of conditions.

4. MONITORING FLIGHT PATH

As sound level of aircraft noise is influenced by the positions of sound sources (aircraft) and a receiving point and the actual flight paths are widely spread, we had to grasp quantitatively precise flight paths.

4.1 Simple Measurement(First Period)

We began to monitor flight paths with simple utencils, a huge protractor and a camera in 1983. As this method could be applied to neither complicated flights (circulation etc.) nor night flights, we could grasp only the tendency of flights.

4.2 Measurement with Theodlite (Second Period)

We developed a new theodlite which can measure both a horizontal and an elevation angles simultaneously. The angles are transformed by encoder with the precision of 0.1 degree and transferred to a personal computer.

From several points a aircraft was observed through telescopes (theodlites) simultaneously. When the aircraft is observed just at the center of telescope image, the observer pushes a trigger button to record its time and angles. Collecting data of each point, a triangulation gives a 3-dimensional locus of the flight. According to this method we can monitor night flight and trace over 20 km long. The spatial error of measurement is within 10m.

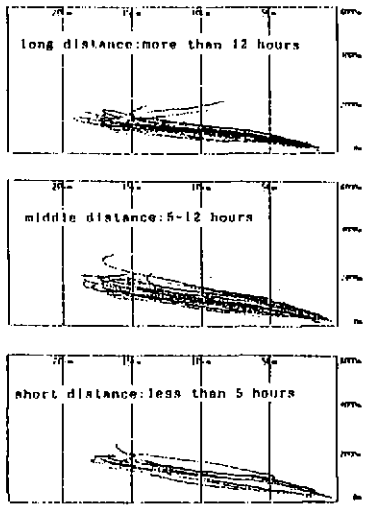

Fig.3. Actual Flight Path.

4.3 Automatic Measurement (Third Period)

As the measurement with a theodlite depends basically on human's eye and is influenced by meteorological condition, it cannot be done in long period.
Measurement by Direction of Sound Source
In order to seize annual distribution of flight paths, the automatic measuring system were set at 2 points in the north side of the airport (Narita City) in 1989. In this system measuring points are set at 1km from the beneath of the flight path so that the aircraft passes between them. At each point, plural microphones measure acoustic intensities. To eliminate noise that is not generated by aircrafts, the field strength of elecro-magnetic wave, transponder signal is also taken into account.

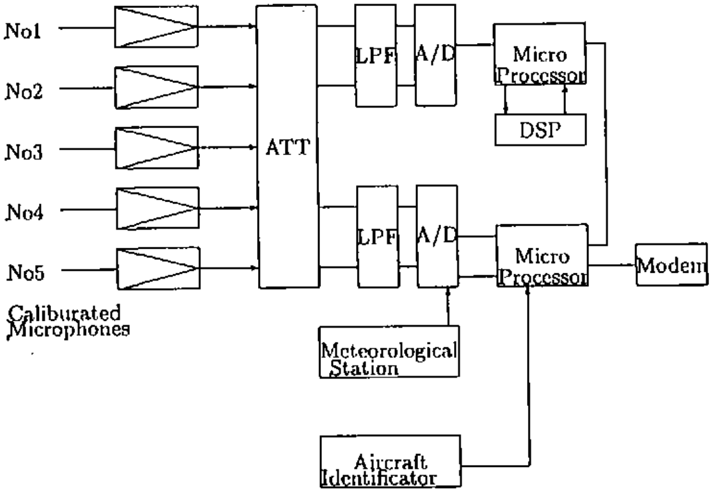

Fig.4. Block diagram of monitoring system of flight paths

5. NOISE SIMULATION

Though the automatic noise monitoring system enables us to grasp airport noise over a wide area through a year, the number of measuring points is not enough for determining of contour line of the noïse distribution exactly. In order to seize noise distribution, the simulation is carried out based on actual measurement. Our simulation method is basically INM's and based on data on power levels of aircrafts and flight paths collected by actual measurements.

(1) Flight Pattern

Using above-mentioned theodlites flight patterns were collected. The patterns are classified by aircraft types, direction and distance. For example, we applied 6 patterns for B747 for takeoff and one pattern for landing.

(2) Noise Level vs Distance Curve

In order to get relation between noise level and distance, we observed flight paths and respective noise levels simultaneously and made spectrum analysis. The data are collected for over 3000 flights with various meteorological conditions.

(3) Result of Prediction

With above-mentioned method, the prediction values differ from observed data within the range of 1dB. This method can be applied to extended area.

Table1. Result of simulation

point	simulation	observed	difference
Isobe	78.7	77.8	0.9
Akaogi	79.2	78.7	0.5
Nogedaira	80.5	80.8	-0.3
Hataya	72.8	73.2	-0.4
Naruge	71.5	72.9	-1.4
Mizukake	73.8	74.6	-0.8
Tatsudai	69.6	69.4	0.2

(4) Application to other Airport

We apply the above simulation to Hiroshima Airport whose scale and number of flights are different from Narita's. Hiroshima Airport was opened in 1993 and is a local one on which about 50 aircrafts land and take off a day. Noise levels are measured at 29 points (4 points constantly) and flight paths are observed during 7 days twice a year. The simulations are also carried out. The prediction values deviate from observed ones within the range of several dB except the area where noise level is very low (under 55 WECPNL).

6. FUTURE PERSPECTIVE OF NOISE MONITORING

We think that the monitoring system is improved not only due to the innovation of the computer technologies but also to the careful examinations of test field data. We plan to develope continuous monitoring system and the noise prediction simulation over a wide area including meteorological conditions. The disclosure of the environmental data is also desired, which will be realized by the internet and so on.

7. ACKNOWLEDGEMENT

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