Research on the Effects of Flight Procedures on Noise Contour Map Around Tan Son Nhat International Airport

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Nomenclature

ANP	Aircraft Noise Performance
ECAC	European Civil Aviation Conference
ICAO	International Civil Aviation Organization
NADP	Noise abatement departure procedures
NPD	Noise-Power-Distance
RWY	Runway

1 Introduction

The level and extent of noise generated by flight operations in terms of noise contour map around Tan Son Nhat International Airport are presented in this study, which is based on two flight procedures recommended by the International Civil Aviation Organization (ICAO) for noise reduction purposes in the airport's vicinity, including NADP 1 and NADP 2.

The availability of certain data, such as target airport data, the number and type of aircraft operating at the airport, and representative flight path analysis for each aircraft type with specific flight procedures, is required to obtain the results of noise calculations. In this research, the noise levels around Tan Son Nhat International Airport were calculated using the flight path segmentation modelling that was recommended by ICAO, Doc 9911 (ICAO, 2008), the flight mechanics equations

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from SAE-AIR-1845 (SAE A21 Committee, 1986) to compute the flight profile, and the Aircraft Noise Performance database from EUROCONTROL to interpolate or extrapolate the noise levels.

2 Method

2.1 Airport Data Collecting

Tan Son Nhat International Airport is one of the largest and busiest airports in Southern Vietnam, serving more than millions of passengers annually in normal operating conditions (Tan Son Nhat International Airport, 2021). RWY 25L/07R and RWY 25R/07L are two parallel runways currently in use at the airport. However, due to the limitation of this research, all flight operations were collected in March 2020 taking place in the runways 25R and 25L with RWY 25L being primarily used for take-offs and RWY 25R being primarily used for landings (Fig. 1).

For noise contour map computing, these two runways are treated as a single runway 25L for both take-off and landing operations because they are parallel and close to each other (365 m). The range of the noise map was limited to ±25 km on the horizontal axis and ±12 km on the vertical axis with the mesh grid of computing domain's origin O (0, 0) located at the start-of-roll point of the runway 25L.

Fig. 1 Tan Son Nhat International Airport

2.2 Aircraft Grouping

For noise assessment, aircraft data from Tan Son Nhat International Airport, including aircraft type and operating frequency, were collected and analysed in March 2020. Individual aircraft types having similar noise and performance characteristics are grouped so that they can be represented by a single aircraft category. The aircraft types operating at Tan Son Nhat International Airport were grouped based on two criteria that were recommended in the ECAC.CEAC Doc 29 (ECAC, 2004) and the ICAO Annex 14 (ICAO, 2013).

2.3 Flight Path Analysis

The flight path of each aircraft group was analysed and calculated using two noise abatement departure procedures, ICAO A and ICAO B, which are equivalent to NADP 1 and NADP 2.

The flight profile was calculated using the equations for flight performance calculations in SAE-AIR-1845 with aircraft engine coefficients from the Aircraft Noise Performance (ANP) database for these variables: engine thrust, take-off, landing ground roll, speeds, and height of each segment of the flight path. The following figure is the flight path of each aircraft group that flies out of Tan Son Nhat International Airport (Fig. 2).

2.4 Noise Calculation

The noise exposure level generated by each flight path segment will be obtained based on interpolation or extrapolation of the Noise-Power-Distance (NPD) table

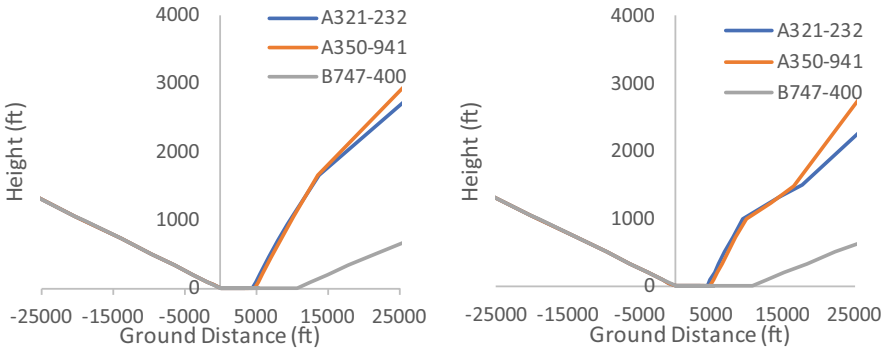

Fig. 2 NADP 1 flight path (left) and NADP 2 flight path (right)

Table 1 The number of take-off-landing movements for each aircraft group with aircraft representatives in March 2020

A/C type	Group	Day	Evening	Night	A/C representative
Airbus A320 Family	C	2813	564	470	Airbus A321
Boeing 787, Airbus A350, Airbus A330	D	438	202	281	Airbus A350
Airbus A340, Boeing 747, Boeing 777	E	160	52	83	Boeing 747
Total		3411	818	834	

using Matlab software with two quantities: engine power (P) and shortest slant distance between the segment and noise receiving point (d). The contribution from one flight path segment to noise exposure level can be expressed as:

$$L_{E,\text{seg}} = L_{E,\text{NPD}}(P,d) + \Delta_v + \Delta_I(\varphi) - \Lambda(\beta,\ell) + \Delta_F(\text{dBA}) \tag{1}$$

where Δ_v, $\Delta_I(\varphi)$, $\Lambda(\beta,\ell)$, and Δ_F in Eq. (1) are called "correction terms" to account for the effects due to the difference between the NPD flight path and the actual flight path.

Based on the number of aircraft movements during the day, evening, and night as listed in Table 1, the day-evening-night equivalent sound level is then calculated based on L_{day} (0700:1900), L_{evening} (1900:2200), and L_{night} (2200:0700) by the following equation:

$$L_{\text{den}} = 10 \cdot \log\left[\frac{1}{24}\left(12 \cdot 10^{L_{\text{day}}/10} + 3 \cdot 10^{L_{\text{evening}}/10} + 9 \cdot 10^{L_{\text{night}}/10}\right)\right](\text{dBA}) \tag{2}$$

The above calculation procedure was done similarly to calculate the day-evening-night sound level caused by three flight paths of three groups of aircraft, A, B, and C, at all noise receiving points in the calculation domain using Matlab software. Finally, the noise contour map for day-evening-night equivalent continuous noise level was established by interpolating the noise levels of all noise receiving points inside the calculation domain around Tan Son Nhat International Airport.

3 Results and Discussion

Figure 3 shows the results of noise contour maps generated by flight operations at Tan Son Nhat International Airport based on the noise abatement departure procedures ICAO A and ICAO B, respectively.

The following figure shows noise contour lines for two flight procedures ICAO A and ICAO B around Tan Son Nhat International airport (Fig. 4).

The difference between the noise levels of two flight procedures occurs within the departure area at the end of the runway. That is because those aircraft following the

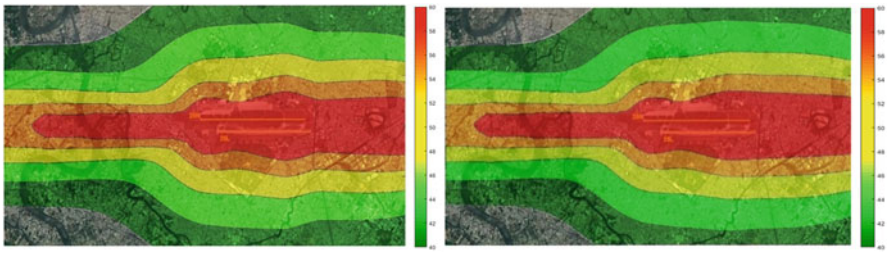

Fig. 3 L_{den} noise contour maps based on ICAO A (left) and ICAO B (right) procedure

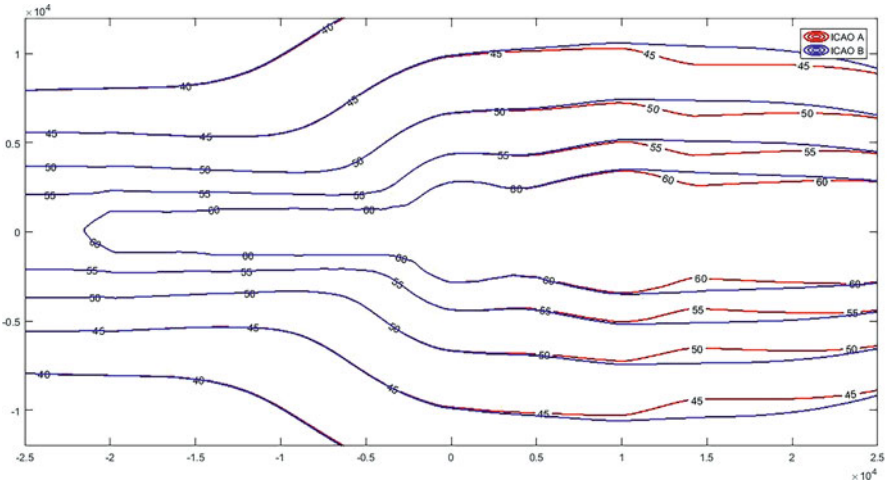

Fig. 4 L_{den} noise contours based on ICAO A and ICAO B procedures

NADP 1 must climb as fast as possible to 3000 ft. and thus the contour lines of the departure area will be slightly narrower than the NADP 2 when the aircraft is far away from the runway.

4 Conclusion

This research has successfully simulated the noise contour map with the noise levels in the range of 40–60 dBA around Tan Son Nhat International Airport and has shown the influence of two noise abatement departure procedures ICAO A and ICAO B equivalent to NADP 1 and NADP 2 on the noise contours.

The results of this study are the basis for effectively assessing the noise level at Tan Son Nhat International Airport for the authority, thereby aiming to provide solutions for rational land use planning in the affected area by high noise levels as well as issuing regulations on noise level limits and aiming to develop noise contour maps for all major airports operating in Vietnam.

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