

NOISE ASSESMENT AND MITIGATION SCHEMES FOR ESTONIAN AIRPORTS

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Abstract. In recent years, concern over airport noise and its impact on surrounding communities has been spurred by the continual growth in air traffic together with urban development in close proximity to many airports around the world. This paper aims at studying the cases of Tallinn Airport and Tartu Airport, both in Estonia, with a focus on evaluating the airport noise and its impact on the neighbouring residential districts. Tallinn Airport is located within the city limits (only 4 kilometres from the city centre), and therefore the inhabited areas are also exposed to aviation noise. The main water catchment area for the city – Lake Ülemiste – and the nearest residential district are situated about 0.5 km from the airport. In 2003 stationary noise monitoring equipment was installed at Tallinn Airport to measure the noise level caused by starting and landing aircraft so that the necessary measures and sanctions can be taken. At Tartu Airport, the noise was recurrently measured in 2008, by using a TES 1352A sound level meter. The

monitoring system at Tallinn Airport and the measurements at Tartu Airport enable operating noise and aircraft noise to be analyzed and predicted as a way to differentiate the landing fees for aircraft depending on noise and flight trajectory. According to the noise monitoring and measurements results, noise maps can be drawn.

Keywords: airport noise, airport environmental impact, noise measurements, noise monitoring, noise level, noisiest aircraft, noise maps, mitigation schemes

1. Introduction

Aviation is a critical component of the global economic infrastructure. If there is to be growth in aviation, however, the environmental impact of aviation must be mitigated (Clarke 2003) The operation of airports results in environmental impacts associated with high levels of noise and vibration (Mato *et al.* 1999) In recent years, concern about airport noise and its impact on surrounding communities has been spurred by the continual growth in air traffic together with urban development in close proximity to many airports around the world (Arafa *et al.* 2007)

Noise pollution is an often forgotten environmental problem that is steadily growing in developing countries (Barboza *et al.* 1995) Noise pollution has been recognized as a serious health hazard (Bies *et al.* 1996)

The World Health Organization (WHO) recommends a noise level of less than 35 dB (A) Leq. during the restorative process of sleep (Mufuruki 1997) It is also often asserted that noise reduces output and efficiency and affects morale. Long-term exposure to noise levels of about 90 dB (A) may lead to permanent hearing loss while prolonged exposure to sounds of 100 dB (A) may cause irreparable damage to the auditory organs. A noise level of about 120 dB (A) is considered painful and may cause instantaneous loss of hearing, while more than 140 dB (A) may produce insanity.

2. Overview of Tallinn and Tartu airports

2.1. Tallinn Airport

Tallinn, the capital of Estonia, is located along the Baltic coast. There are five international airports in Estonia, but only Tallinn Airport has considerable passenger traffic. Tallinn Airport belongs to the category 4E (general), Cat I (navigation), and 7 (fire-rescue), and its runway is 3070 m long and 45 m wide. From the point of view of environment protection, the location of Tallinn Airport is not good because the airport is located very near to the city (only 4 km south-east of the Tallinn city centre). The main water resource for city needs – Lake Ülemiste – and the nearest residential district are situated about 0.5 km from Tallinn Airport. The closest coherent residential areas are situated in Mõigu, about 500 m south-west of the airport, and Sikupilli, about 1500 m north-west of it. The airport produces noise during both development and operational phases. Crucial issues involve the location of airport users and employees and the flight path and engine testing during operation of the airport. Although one of the districts of Tallinn is situated under the trajectory of aircraft taking off and landing, the inhabitants of Tallinn have very seldom lodged protests against the noise.

2.2. Tartu Airport

Tartu Airport has an important role in Estonian regional policy as an educational centre and gateway to Europe. Tartu Airport is also important in the regional development of the southern part of Estonia; there is a plan to begin regular flights to attract enterprises and tourists to southern Estonia. The length of the runway is 1,799 m and its width is 31 m. The load capacity of the runway is 65 tonnes.

3. The objectives of the study

The objectives of this study were:

3.1. Tallinn Airport

- to measure the noise levels generated by aircraft at Tallinn Airport and its surroundings,
- to specify the noisiest types of airplanes at Tallinn Airport,
- to suggest measures for reducing noises or their impacts.

3.2. Tartu Airport

Research work was focused on the survey of aviation noise at Tartu Airport. There have been several complaints about the noise in the areas surrounding Tartu Airport. The main goal of this research was to find out whether the maximum noise level of flight operations exceeded the allowed levels or not.

4. Noise measurements

4.1. Tallinn Airport

In 2003 stationary noise monitoring equipment was installed at Tallinn Airport to measure the level of noise caused by starting and landing aircraft so that the necessary measures and sanctions can be taken.

At present Tallinn Airport has the following device for metering and modelling the noise level:

- two stationary noise level monitoring terminals,
- one mobile terminal,
- software to monitor flight-trajectories (company Topsonic),
- software for modelling the noise level (Danish method).

One stationary monitoring station is located on the grounds of the airport and surrounded by a fence. Data is transferred from the stationary noise monitoring terminals grounds of the airport to the central unit by cable.

One stationary monitoring station located outside the grounds of the airport. Data transferred from the

stationary noise monitoring terminals outside the grounds of the airport to the central unit by using lines of Estonian Telecom.

One station is equipped with weather sensors to measure the wind speed, wind direction, temperature, and air pressure.

According to the noise monitoring and measurement results at Tallinn Airport, noise maps were prepared (Appendices).

4.2. Tartu Airport

Measurements took place on 7 April 2008 during training flights. The measurements were carried out at the end of the landing flights on the 26th runway, by the NDB beacon, and in the living area situated at the end of the same runway. The measurement results were registered and the places of measurements were marked on a map. The measurement duration of the noise event was 1 minute on the average. The measurement device was held over the head of the measurer to achieve the most adequate results and also to achieve conditions that were similar to the conditions in an open area. The type of plane that performed the training flights was a “Piper Navajo PA-31-310”. No regular commercial air traffic has been operated by Tartu Airport since 2001. The airport facilities have been used mainly as a training base for student pilots who are studying at the Estonian Aviation Academy. For training flights, training planes such as the “Cessna 172” and “PA-31-310” (Piper Navajo) are used. The noise generated by the double-engine “Piper Navajo PA-31-310” is considerably higher than that made by the “Cessna 172”. It was this higher noise level emanating from the “Piper Navajo PA-31-310” that provided the need for recurrent measurements of noise at Tartu Airport in 2008. The correction of the background noise was done according to formula 1.

$$L_{at} = 10 \times \log(10^{\frac{L}{10}} - 10^{\frac{L_b}{10}}) \tag{1}$$

where L_{at} – corrected noise level, dB; L – summarized noise level, dB; L_b – background level, dB.

5. Results and discussion

5.1. Tallinn Airport

A peculiarity of air traffic distribution in Tallinn is that only about 18 % of take-off and approaches take place above the city, west of the airport, and 82 % above the not densely built-up land east of the airport (Tab 1).

The following table shows the runway use for overall traffic in 2008.

Table 1. Runway use for overall traffic in 2008

| Number of flights | RWY usage % | |
|-------------------|-------------|--------|
| | RWY 08 | RWY 26 |
| 176,464 | 17.87 | 82.13 |

As the annual average traffic is relatively small in/from western directions, the area exposed to relevant noise input is smaller in the west than in the east. To maintain take-offs and landings from eastern directions as the preferred options is regarded as an appropriate mitigation measure concerning increasing air traffic. Already the current permits for airport operations state that at night only these flight directions are normally allowed. When the wind from the west is not too strong, landings from and departures in eastern directions are anyway more favourable.

The noisiest types of airplanes at Tallinn Airport are the “IL 62” and “AN 124” (Fig 1).

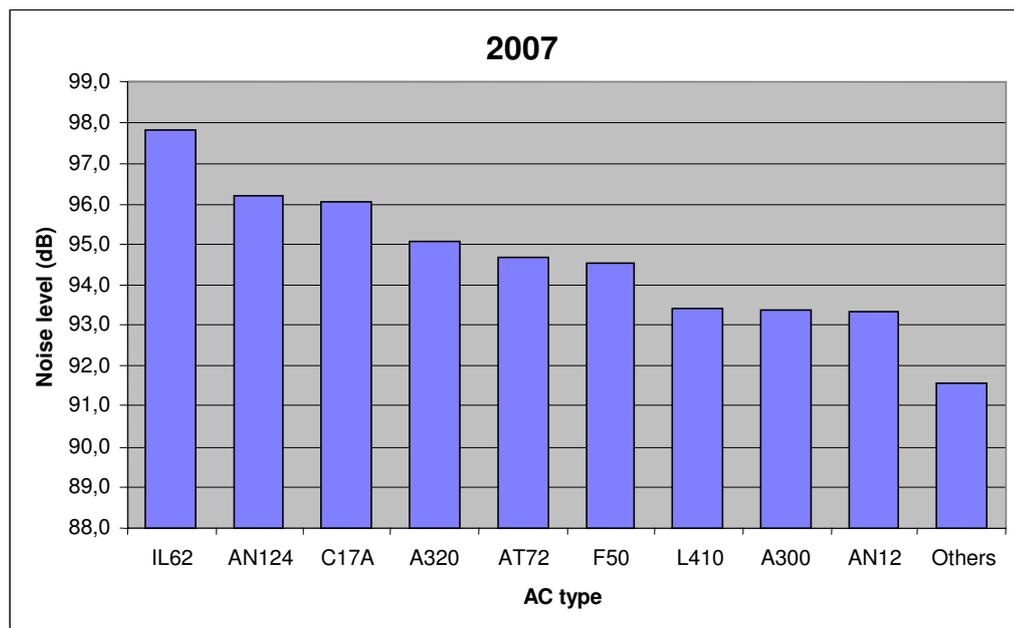


Fig 1. Airplanes emitting the highest noise level dB

5.2. Tartu Airport

Table 2 presents the maximum values of each measurement of sound pressure in decibels on an A-corrected scale, and the average noise level during the

measurement period. Maximum values are reached by processing the data obtained afterwards.

If taken as a premise that the levels given in table 2 are maximum aggregate noise levels, we can calculate the corrected noise levels by formula (1). The results of the calculation are given in table 3.

Table 2. Maximum values of sound pressure $L_{pA,max}$ and the average value of sound pressure during measurement period

| Location | Type of aircraft | Maximum sound pressure level $L_{pA,max}$ (dBA) | Average sound pressure value during measurement period (dBA) |
|-----------------------------------|------------------------|---|--|
| NDB (measurement 1) | Piper Navajo PA-31-310 | 83.2 | 63.3 |
| NDB (measurement 2) | Piper Navajo PA-31-310 | 84.4 | 61.8 |
| NDB (measurement 3) | Piper Navajo PA-31-310 | 88.6 | 64.7 |
| Crossroad | Piper Navajo PA-31-310 | 79.9 | 59.0 |
| Field next to residential area | Piper Navajo PA-31-310 | 89.4 | 63.1 |
| Within residential area (meas. 1) | Piper Navajo PA-31-310 | 79.4 | 53.5 |
| Within residential area (meas. 2) | Piper Navajo PA-31-310 | 78.5 | 54.7 |

Table 3. Maximum corrected noise levels dBA

| Location | Type of aircraft | Max corrected sound pressure level $L_{at,max}$ (dBA) |
|---|------------------------|---|
| NDB (measurement 1) | Piper Navajo PA-31-310 | 83.19 |
| NDB (measurement 2) | Piper Navajo PA-31-310 | 84.39 |
| NDB (measurement 3) | Piper Navajo PA-31-310 | 88.60 |
| Within residential area (measurement 1) | Piper Navajo PA-31-310 | 79.40 |
| Within residential area (measurement 2) | Piper Navajo PA-31-310 | 78.50 |

5.3. Mitigation schemes for Tallinn Airport

Mitigation schemes for Tallinn Airport include the following noise abatement procedures (Aeronautical... 2008):

1. **General provisions** – noise abatement procedures are applicable below the altitude of 3000 FT MSL.
2. **Preferential runways :**
 - a) take-off: RWY 08; RWY 26;
 - b) landing: RWY 26; RWY 08.
3. **Special procedures** – IFR flights departing from RWY 26 shall adhere to procedure A defined in ICAO Doc 8168-OPS/611 volume 1, part 5:
 - a) take-off to 1500 FT above aerodrome elevation:
 - take-off power,
 - take-off flap,
 - climb at $V_2 + 10$ to 20 KT (or as limited by body angle).
 - b) at 1500 FT:
 - reduce thrust to not less than climb power/thrust.
 - c) 1500 FT to 3000 FT:
 - climb at $V_2 + 10$ to 20 KT.
 - d) at 3000 FT:
 - accelerate smoothly to en-route climb speed with flap retraction on schedule.
4. **Use of the runway at night:**

- a) RWY26 is not used between 2000 and 0400 for departures of aircraft with MTOW exceeding 136 tonnes;
- b) exceptions are subject to CAA permission and will be accepted for justified reasons only.

5. **Training flights** – no limitations.

6. **Maintenance run-up** – Maintenance run-ups of aircraft engines must be avoided between 2000 and 0400 and at any time on Sundays.

5.4. Mitigation schemes for Tartu Airport

As can be seen, the result obtained does not exceed the maximum daily critical level of sound pressure of $L_{pA,max} = 90$ dBA in any of the locations measured. Yet, in two cases the sound pressure level was higher than the maximum noise level (which is 85 dBA in the daytime) allowed for sound pressure caused by air traffic.

The residential area where measuring was carried out is also, in addition to being located beneath the air corridor, exposed to railway traffic and the noise arising from that.

When selling a plot of land, a real estate developer has the task of informing the client about the neighbouring infrastructure. It is up to the concrete client whether to move into the vicinity of an airport or not, as an airport cannot move anywhere else.

In general it is forbidden to build new noise sensitive buildings in areas where the noise level exceeds the maximum critical level of sound pressure.

6. Conclusions

The purpose of noise monitoring is to inform the airport, airlines, local community and government about noise pollution. According to noise monitoring results and noise modelling, noise maps can be drawn. With the help of a noise monitoring system, it can be controlled that aircraft will proceed in its trajectory. It is important that the aircraft will not make louder noise than 85 dBA at the measurement points. The noisiest airplanes at Tallinn Airport are the IL 62 and AN 124.

The results of the measurements made by the authors of this paper at Tartu Airport indicate that the maximum levels of noise allowed were not exceeded. But still, the noise exceeded the allowed air traffic noise level on two occasions. The biggest margin between the allowed level and the measurement result was 4.4 decibels. That is not very significant but actually still very disturbing for the residents living in an area affected by noise pollution.

It is evident that the reopening of regular flights will have an effect on the noise level in the vicinity of the airport. But since the planned number of flight operations per day does not show dramatical increase, all noise levels will remain within the norms in the future as well. The noise level also certainly depends on the type of aircraft selected for the given flight and on the amount noise emitted by those aircraft.

One has to take notice of the peculiarities of take-off and landing procedures as well. When the Tartu Airport runway is made longer, the take-off can be started from further away at the beginning of runway 08. This will enable the airplane to gain more altitude before flying

over the inhabited area. Less noise will reach the ground from the greater altitude, and thus the noise level will be lower. And after the installation of the ILS, the approach procedures will be less dangerous and more accurate.

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GARSINIO UŽTERŠTUMO ĮVERTINIMAS IR JO MAŽINIMO SCHEMOS ESTIJOS ORO UOSTUOSE

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S a n t r a u k a

Pastaraisiais metais nerimo faktorius, atsiradęs dėl triukšmo, sukeliama oro uostuose ir jo poveikio aplinkiniams gyvenamiesiems rajonams, tapo rimtesnis, nes gausėja orlaivių, taip pat oro uostai įsikuria per arti gyvenamųjų rajonų.

Šių tyrimų tikslas buvo nustatyti Talino ir Tartu oro uostų keliamo triukšmo lygį bei jo įtaką aplinkiniams gyvenamiesiems rajonams.

Tarptautinis Talino oro uostas yra įsikūręs miesto ribose (tik 4 km atstumu nuo miesto centro). Tai reiškia, kad nemažai gyventojų kenčia nuo orlaivių keliamo triukšmo. Pati artimiausia gyvenvietė yra nutolusi nuo oro uosto tik 0,5 km atstumu. Julemistės ežeras, kuris yra miesto geriamojo vandens šaltinis, taip pat yra oro uosto apylinkėse.

2003 m. Talino oro uoste buvo pastatyta triukšmo lygio matavimo įranga, kuri turėjo ne tik nustatyti kylančių ir besileidžiančių orlaivių sukeliama triukšmo lygį, bet ir numatyti būtiną priemonę jam sumažinti bei taikyti sankcijas. 2008 m. Tartu oro uoste triukšmas matuotas kelis kartus naudojant triukšmo matuoklį TES 1352A.

Ši triukšmo matavimo sistema leidžia pirmiausia išanalizuoti ir nustatyti orlaivių bei kitos įrangos keliamo triukšmo lygį ir tuomet diferencijuoti rinkliavas už nusileidimą, kurios priklauso nuo sukeliama triukšmo lygio ir skrydžio trajektorijos. Priklausomai nuo triukšmo kontrolės ir jos rezultatų, galima nupiešti triukšmo žemėlapius.

Reikšminiai žodžiai: oro uosto triukšmas, oro uosto aplinkos įtaka, triukšmo matavimas, triukšmo lygis, triukšmingiausi orlaiviai, triukšmo žemėlapiai, sumažinimo schemos.

Appendices

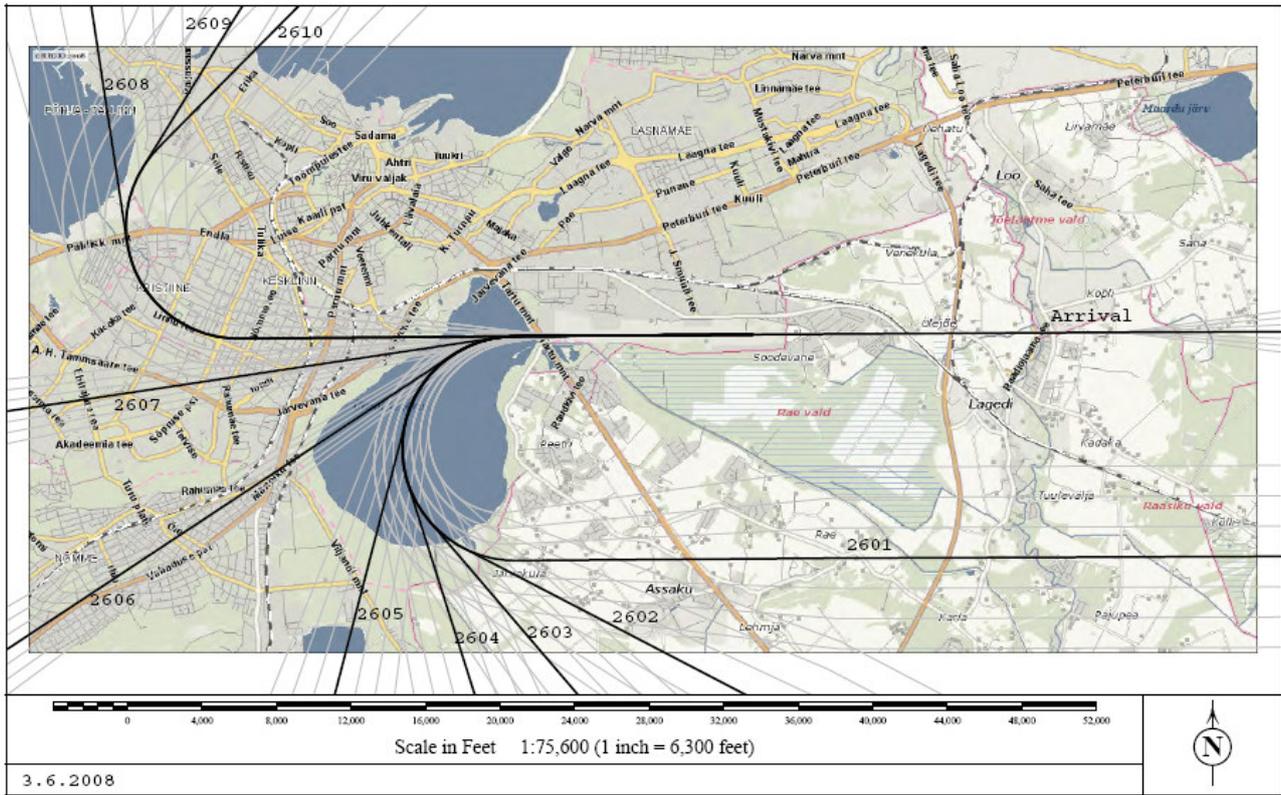


Fig 1. Tallinn Airport. Noise map according to Directive 2002/49/EC. Air corridors of runway 26

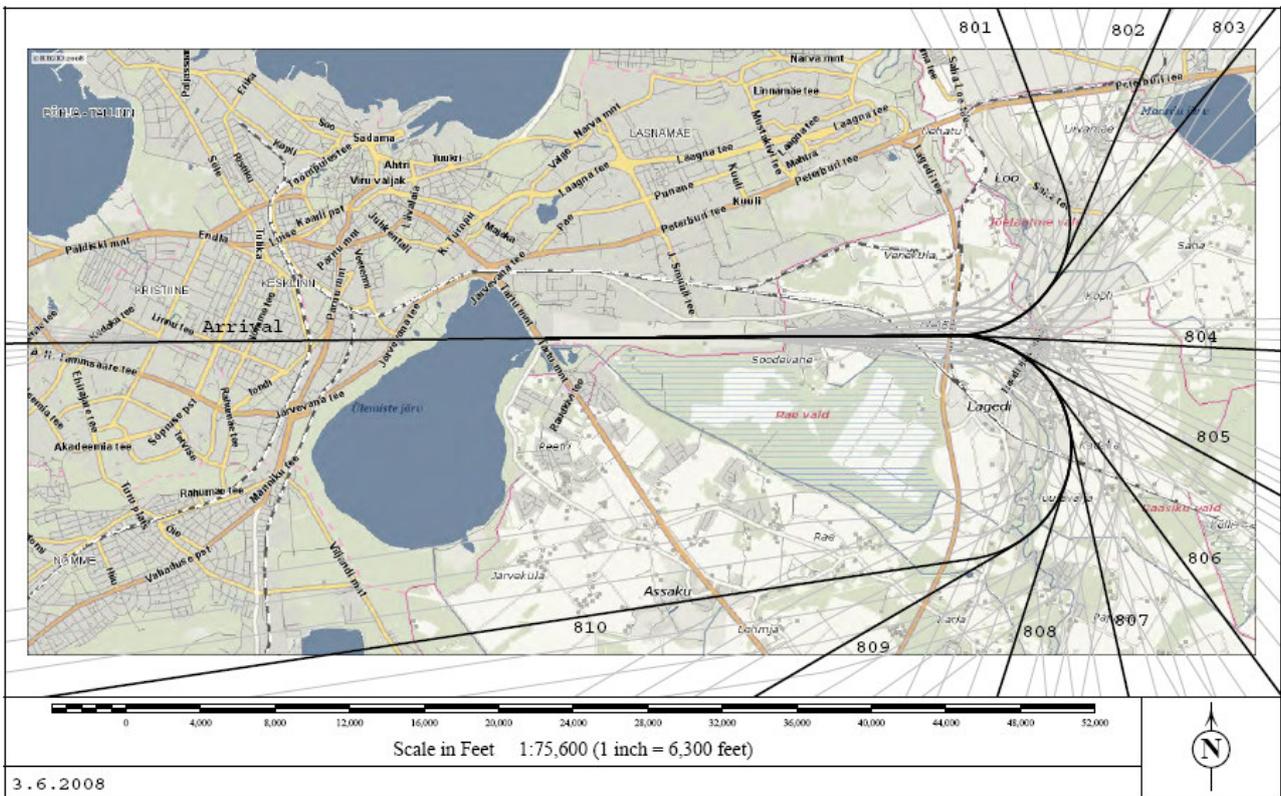


Fig 2. Tallinn Airport. Noise map according to Directive 2002/49/EC. Air corridors of runway 08

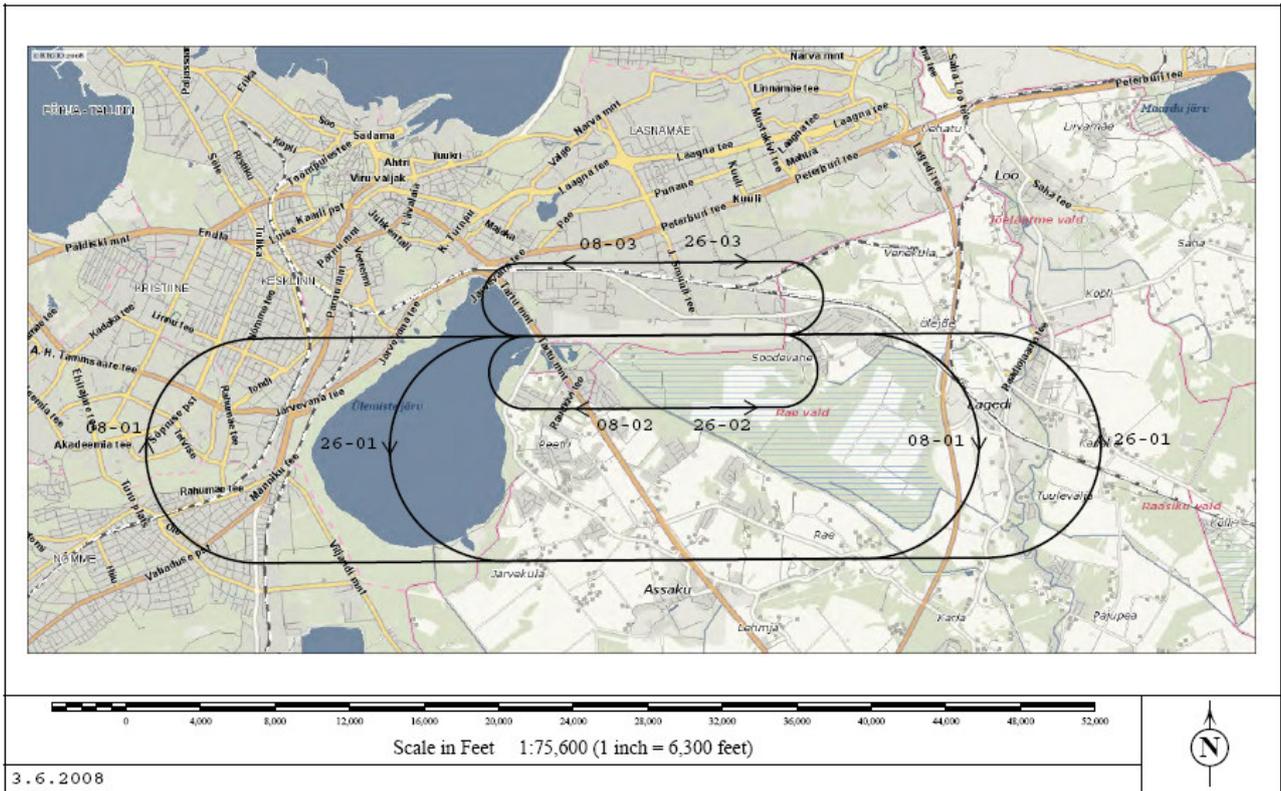


Fig 3. Tallinn Airport. Noise map according to Directive 2002/49/EC. Air corridors for training purposes

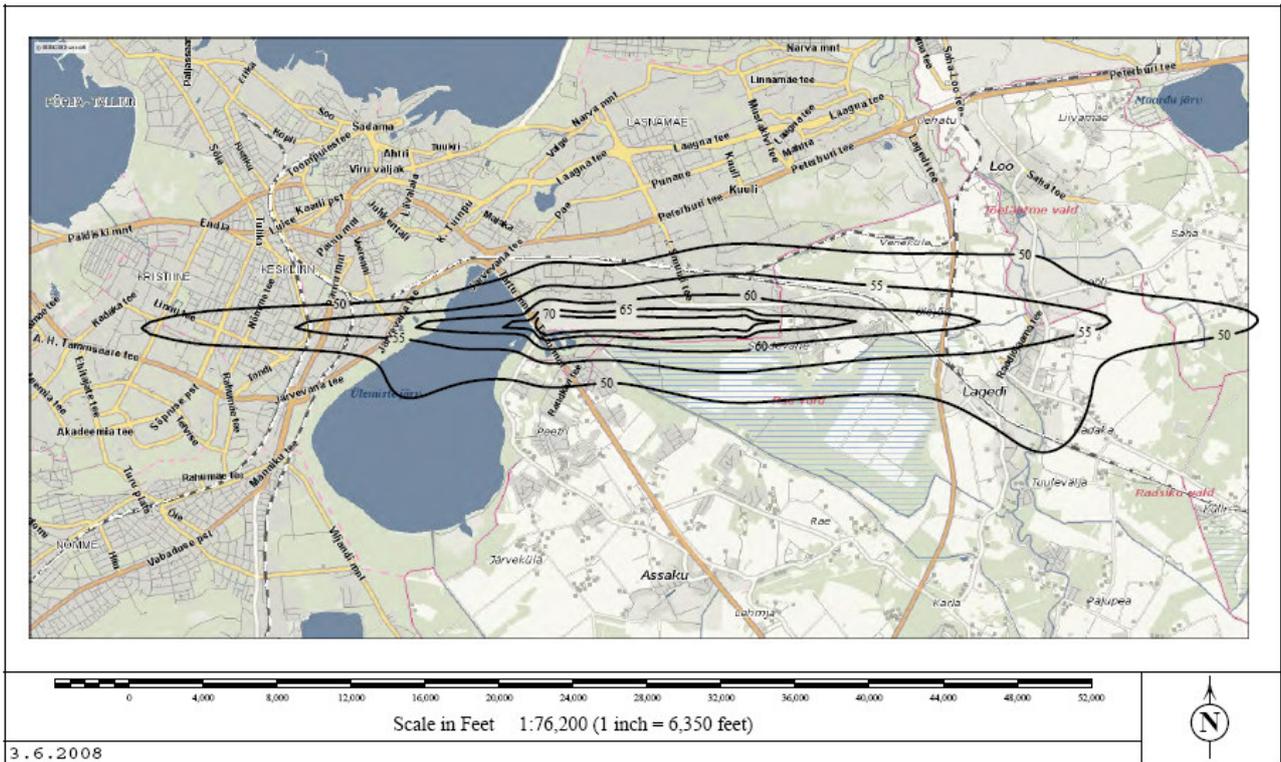


Fig 4. Tallinn Airport. Noise map according to Directive 2002/49/EC. Lden noise contours. 2006 average traffic

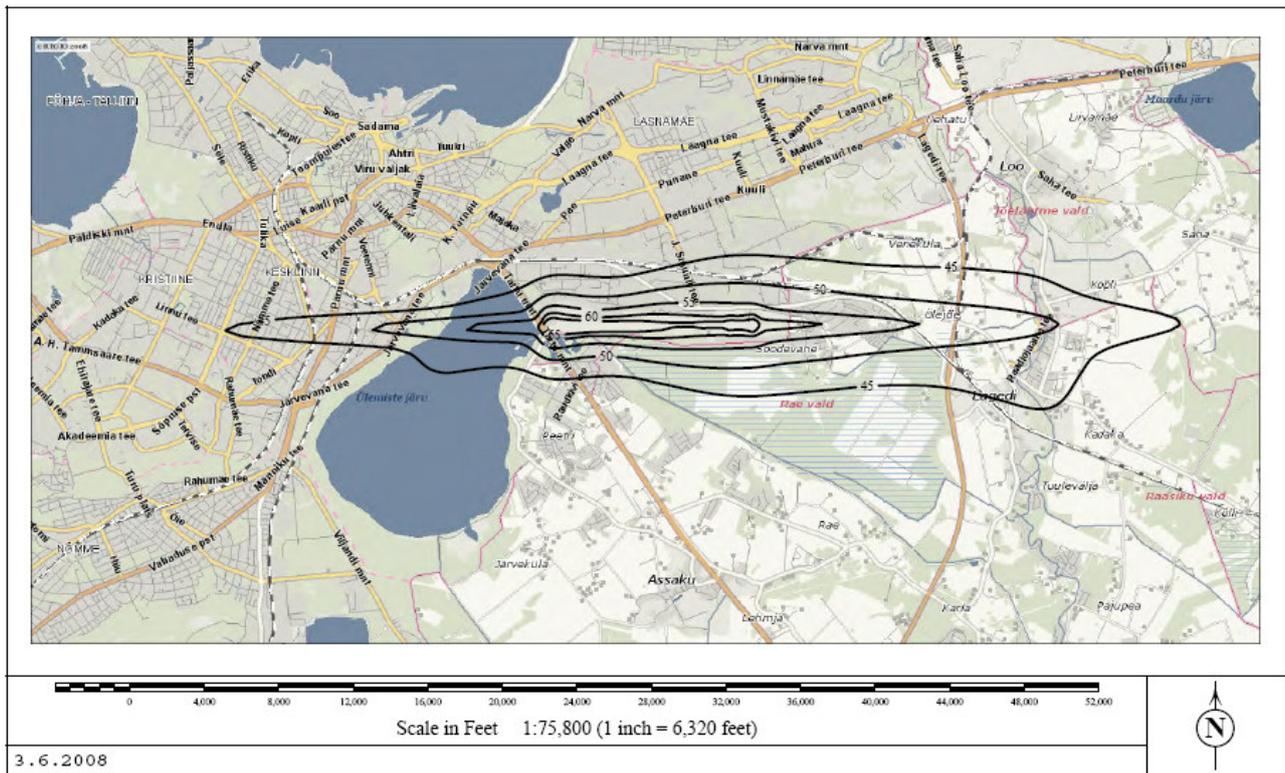


Fig 5. Tallinn Airport. Noise map according to Directive 2002/49/EC. Lnight (23-07) noise contours. 2006 average traffic

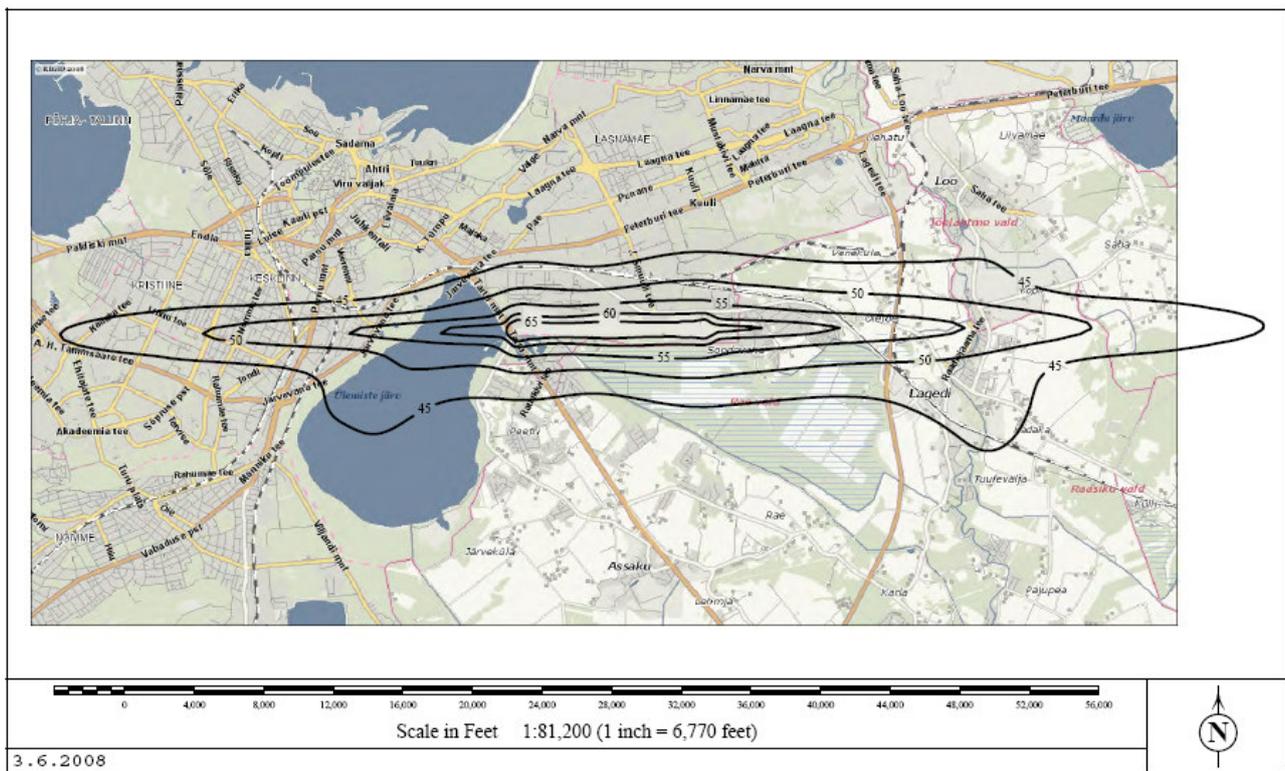


Fig 6. Tallinn Airport. Noise map according to Directive 2002/49/EC. Lday (7-23) noise contours. 2006 average traffic

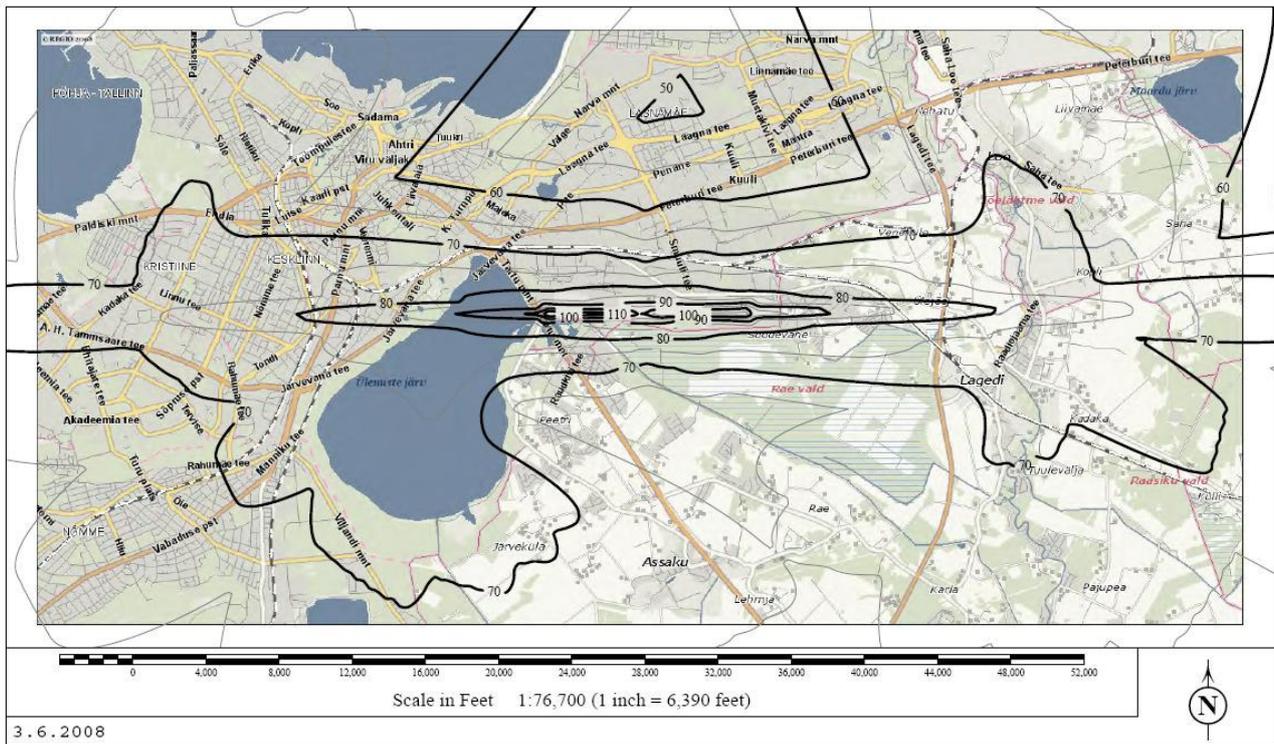


Fig 7. Tallinn Airport. Noise map according to Directive 2002/49/EC. LMax (7-23) noise contours. 2006 average traffic

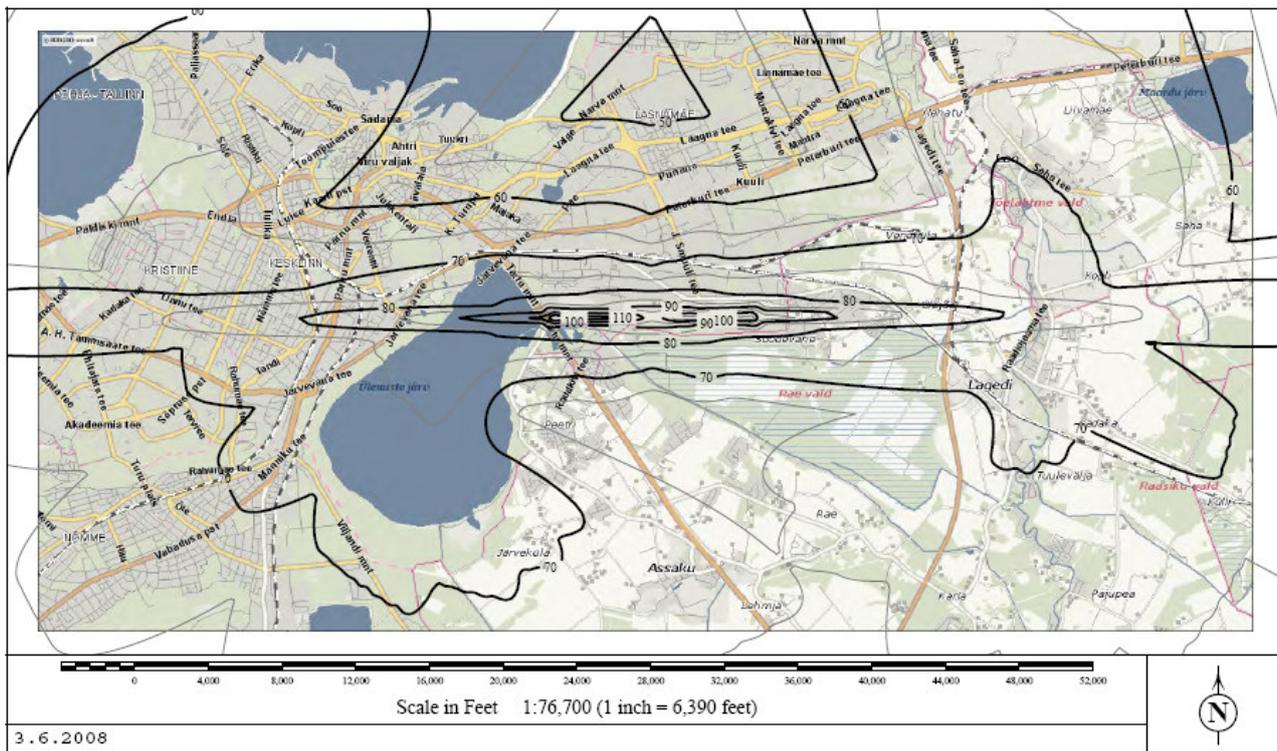


Fig 8. Tallinn Airport. Noise map according to Directive 2002/49/EC. LMax (23-7) noise contours. 2006 average traffic