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Saulėtekio ave 11, LT-10223 Vilnius, Lithuania
Phone: +370 5 2745090; Fax.: +370 5 2744731; e-mail: ap2008@ap.vgtu.lt

INVESTIGATION OF NOISE LEVEL IN TRAKAI CITY DURING DAY

Donatas Butkus[1], Klaus-Dieter Frohner[2], Raimondas Grubliauskas[3]

[1,3]Vilnius Gediminas Technical University, Department of Environment Protection, Saulėtekio al. 11, LT – 10223 Vilnius, Lithuania. E-mail: [1]butkus@ap.vgtu.lt; [2]raimon@ap.vgtu.lt
[2]Vilnius Institute of Ergonomics, Hamburg University of Technology, Eissendorfer Strasse 40, 21073 Hamburg, Germany. E-mail: arbeitswissenschaft@tu-harburg.de

Abstract. Through the last 10 years noise in the cities grew up meanly 0.5 – 1 dB per year. Noise is having direct impact on human health also on living and recreation environment quality.
For our investigation the town of Trakai was chosen. Trakai is the center of a region; also it is very important as historical and as recreation site, where history and nature are combined together as harmony as a whole. That is why, especially in the period of warm season, there are a lot of tourists and guests arriving by different means of transport.
To estimate the noise level rate per 24 hours, the levels of noise were measured in 16 places. Noise was measured in July 2007, three times per day (day – 6.00 – 18.00 h, evening – 18.00 – 22.00 h and night 22.00 – 6.00 h). For the measurement of noise levels „Bruel&Kjaer 2260 Mediator" noise level meter was used.
From measurement of noise levels during day time we can see, that the highest equivalent noise levels were measured in sites near the main streets of the town and near the night club „Salos". The measured noise levels reached 61 – 64 dB(A), and did not exceed the limit of noise level which is 65dB(A)
Measures of noise levels in the evening time determined that the highest levels of noise also as in day time were near main streets of the town and near night club „Salos". Here the levels of noise varied from 57 to 62 dB, and the highest 75 dB equivalent level of noise was measured near the crossroad of the most intensive streets.
The limit of noise level during night time exceeded only in one site near the exit of Trakai town, in the other sites the level of noise varied from 45 to 53 dB(A) and did not exceed the limit of noise level (55 dB(A).
To compare the levels of noise in different times of a day, it is seen, that higher level of noise is measured in the evening time was 1,2 dB(A) higher than measures which were made during day time.

Keywords: Traffic noise, noise level, investigation of noise level, railway, Trakai town.

1. Introduction

Transport is a big part of our life. Noise level increases with the increasing traffic [1]. During the last 10 years, noise levels in the town increased by approximately 0.5-1 dB per year. In most towns, the average noise increase is 1-3 dB per year [2]. It is forecasted that in 15 years the noise level will double [3]. Noise has a major direct impact on human health and the quality of living and recreational environment. Constant noise acts as a factor causing nervous strain and stress; therefore, the World Health Organization (WHO) attributed noise to the physical factors that induce and spread professional diseases [4]. Permanent noise affects auricular system. Besides, noise may cause other health problems or affect life quality [5].

Many town citizens suffer from the traffic-generated noise. Traffic is the most prevailing source of noise in the town [6]. Traffic-generated noise accounts for 60–80% of the noise prevailing in the towns. It has negative effect in all the territories of the towns: residential areas, hospitals, sanatoriums, recreation areas, town centre, utility and industrial territories [7].

Up till now, the noise problem was given very little attention. About 20 percent of the population of the European Union, i. e. 80 million people, suffers from the health-affecting noise. In Lithuania, as well as in other countries, efforts are made to reduce the surrounding noise and avoid its adverse impact on human health and the quality of environment [8].

Therefore, the noise generated by new cars decreased since 1970. Unfortunately, despite these achievements, with increasing intensity of motor traffic, the impact of noise on people did not decrease during the last years [7]. Negative impact of transport

on the environment increasingly becomes a relevant issue in Lithuania.

Around the world, in order to humanize and ecologise the environment, shields and walls protecting from noise and pollution are being built near the streets with intensive traffic, highways and noisy factories [9].

Traffic noise as a pollutant has not been evaluated to the same extent as the exhaust gases; yet, foreign researchers consider the impact of noise as the most harmful for humans after the impact of carcinogenic substances contended in the exhaust gases [10].

2. Methodologies of noise measurement

The purpose of the noise study is to measure and evaluate the dynamics of noise in Trakai town in the course of 24 hours, when the noise is generated by traffic and stationary sources. The locations of noise measurement where the noise was measured in three periods – in the day time (6 am to 6 pm), in the evening (6 pm to 10 pm) and at night (10 pm to 6 am) are presented in Table 1 [11].

Table 1. Locations of noise level measurement in Trakai town

Town	Measurement locations	Number of noise level measurement locations
Trakai	Vytauto street	4
	Karaimų street	4
	Entertainment and health centre “Trasalis”	2
	Night club “Salos”	2
	Trakai railway station	2
	Trakai bus station	2

The town of Trakai was chosen for the study. Trakai is a district centre and a tourist destination; besides, it is a recreation place where the history and nature merges together into harmonious entirety. Therefore, particularly in the warm season, there are many tourists and visitors arriving to the town. For the measurement of noise level, 16 measurement locations were selected in Trakai town. They are located near Trakai railway and bus stations, entertainment and health centre “Trasalis”, night club “Salos” and on Vytauto and Karaimų streets.

The plan of noise measurement locations in Trakai is presented in Fig 1 and 2

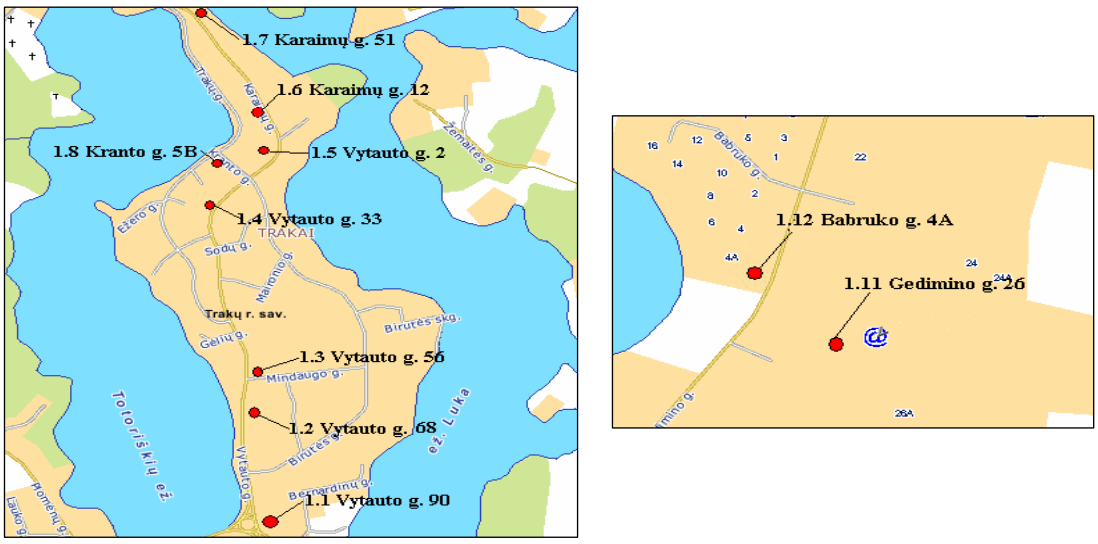

Fig 1. Plan of ambient noise measurement locations 1.1 – 1.12 in Trakai town

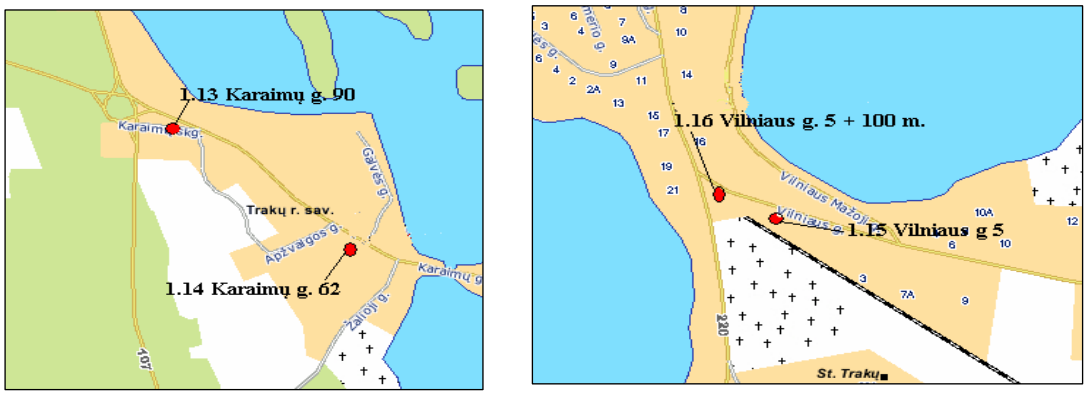

Fig 2. Plan of ambient noise measurement locations 1.13 – 1.16 Trakai town

Measurement location No. 1.1, Vytauto str. 90. Measurement location is near a beauty parlour in a two-storied building in the territory of the bus station. To the left from the measurement location, in 100 metres, there is a market place. In front of the measurement location there is a bus station. Behind the bus station, there is Vytauto street with high-intensity traffic. The distance from the measurement location to Vytauto street is about 60 metres.

Measurement location No. 1.2, Vytauto str. 68. Measurement location is within 5 metres distance from Vytauto street. It is 2 metres below street level, lined with some trees, and on the other side of the street, there is a shopping centre. The noise level at this location is influenced by the passing traffic on Vytauto street.

Measurement location No. 1.3, Vytauto str. 56. Noise measurement location was selected near a shopping centre, within 8 metres distance from the main, Vytauto street. To the left from the measurement location, in 40 metres, there is a block of flats and a side street, Mindaugo street. In from of the street, next to the shopping centre, there is a parking lot.

Measurement location No. 1.4, Vytauto str. 33. Noise measurements were performed within 25 metres from Vytauto street, near a three-storied brick building. There are some trees between the measurement location and Vytauto street.

Measurement location No. 1.5, Vytauto str. 2. Noise measurement location is near a two-storied public building. The distance from the measurement location to Vytauto street is 4 metres. To the right from the measurement location, there is a parking lot.

Measurement location No. 1.6, Karaimų str. 12. Measurement location is within 7 metres distance from Karaimų street. There are no barriers to reduce the noise at this location. There is one-way traffic on Karaimų street at this measurement location.

Measurement location No. 1.7, Karaimų str. 51. Noise level measurement location is selected near a one-way street, one lane of which is occupied by parked cars. Measurements were performed within 3 metres distance from the street. The street is lined with two-storied living wooden houses. Most of the buildings have windows with wooden frames.

Measurement location No. 1.8, Kranto str. 5B. Noise level measurements near the night club "Salos" were performed within 10 metres distance from Kranto street. To the left of the measurement location there is a side street, Trakų street. In front of the measurement location, on the other side of the street, there is Totoriškių lake.

Measurement location No. 1.9, Kranto str. 5B. Noise level measurement location is within 20 metres distance from Kranto street. The measurements were performed behind the parking lot of the night club "Salos". The traffic is a bit less intensive on Trakų street in front of the measurement location, because part of the transport turns to Kranto street.

Measurement location No. 1.10, Birutės str. 48. Noise level measurement location was selected near the building of Vytautas the Great Gymnasium in Trakai. It is within 100 metres distance from the bus station. The space in front of the measurement location is fenced by buildings and vegetation; therefore both the noise from the street and from the bus station is subdued.

Measurement location No. 1.11, Gedimino str. 26. The distance from the noise measurement location selected near entertainment and health centre "Trasalis" to Gedimino street is 80 metres. To the right of the measurement location, there is a hotel and a restaurant and a large parking lot. On Gedimino street, which is in front of the measurement location and has intensive traffic, cars are driving from Trakai to Rūdiškes.

Measurement location No. 1.12, Babruko str. 4a. Measurement location was selected near a two-storied residential building at Babruko str. 4a. This measurement location is within 10 metres from Gedimino street. In front of the measurement location, on the other side of Gedimino street, there is an entertainment and health centre "Trasalis". The measurement location is not protected from the traffic-generated noise.

Measurement location No. 1.13, Karaimų str. 90. Measurements of traffic-generated noise were performed near a two-storied residential building

within 10 metres distance form Karaimų street. The building is about 2 metres below the street level.

Measurement location No. 1.14, Karaimų str. 62. Noise level measurements were performed within 5 metres distance from the building No. 62 on Karaimų street. This one-storey wooden house with and attic is surrounded by bushes, there are also some trees, but they do not help a lot in reducing the noise.

Measurement location No. 1.15, Vilniaus str. 5. Measurements were taken within 10 metres distance from the railway. This measurement location is separated from Vilniaus street running in parallel to the railway by a lush row of trees; therefore, the noise in this measurement location is only caused by the railway transport.

Measurement location No. 1.16, within 100 metres distance from the house at Vilniaus str. 5. The measurements were performed within 100 metres from the railway. This measurement location is closer to Gedimino street, and it is separated from Vilniaus street by a lush row of trees.

On 25 July 2007, during the test, it was established that the air humidity in the day time was 74.1 %, air temperature - 18.4 ^{0}C, wind speed – 0.9 m/s. In the evening, the tests were made under air humidity of 69.7 %, air temperature of 20.5 ^{0}C and wind speed of 1.1 m/s. When noise tests were performed at night, the weather conditions were as follows: air humidity - 74.8 %, air temperature - 16.0 ^{0}C, wind speed -1.1 m/s.

Noise level was measured in 16 measurement locations. In order to establish the levels of traffic-generated noise at different times of the day, 10 measurement locations were selected. 2 locations were selected for evaluating railway traffic noise, and 4 locations were selected for measuring noise generated by entertainment and industrial objects.

Measurements of stationary and mobile sources of noise are performed with Bruel&Kjaer mediator 2260. When measuring noise level with Bruel&Kjaer mediator 2260, the relative measurement bias is ± 1.5%. This device can be used to measure equivalent and broadband noise parameters. The devise registers noise within frequency range of 6.3 Hz and 20 kHz, in the frequency band of one or 1/3 octave. It can be used to measure the effective noise level defined by characteristics A, B or C or in separate octaves, which are separated by standardised filters. The frequency range is measured starting from the lowest frequency and the measurements are taken for all frequency values (31.5 – 8 000 Hz).

Before performing the noise level measurements, meteorological conditions should be established: relative air humidity, air temperature and wind speed. This data determines whether the measurements can be performed. It can not be done when it's snowing, raining, when there is a mist or the wind speed exceeds 5 m/s. When the wind speed is 5 m/s, microphone is covered with a special shield.

In the territories near residential buildings, hospitals, sanatorium, kindergartens, schools and other training institutions, the noise is measured at least in three points located within 1–2 m distance from the façade, 1.5 m above the surface of the terrain. During the measurement, microphone shall be pointed to the direction of maximum noise, no more than 0.5 m away from the person performing the measurements.

Measurement of road traffic-generated noise. Measurements of the traffic-generated noise are taken in the territories within the zone of influence of the traffic-generated noise. Measurement locations are selected considering the amount and speed of the passing traffic in different sections of the streets, background noise of the area, the vegetation and the development of the area. For the investigation of road traffic-generated noise, the streets were selected where the number of measurement locations is selected according to the passing traffic flow. The measurement locations in Trakai were selected within similar intervals from each other (within 500–800 metres distance). When measuring noise levels, motor traffic is divided into two categories: light and heavy. The noise level of cars is characterised by equivalent and maximum sound level of passing cars measured within 7.5 metres distance from the road side. Taking into account the development of the area and the peculiarities of noise dispersion, distances can be adjusted.

Measurement of railway-generated noise. Measurements of the railway-generated noise are taken in the residential areas within the zone of influence of the railway-generated noise. The noise levels are measured without dividing railway transport into categories because passenger trains are the only kind of trains arriving to Trakai railway station. When investigating the railway-generated noise, the number of train wagons passing during the time of measurement is counted.

During the measurements, microphone is held within 50 and 100 metres from the railway. At the locations within 100 metres, noise levels are measured in order to establish the noise levels of the protective sanitary zone of railways, which is 100 m away.

The noise generated by railway traffic and road traffic is measured by holding the microphone square with the railway or road line. Measuring of the railway noise starts when the train crosses the alignment line. Measuring is finished when the last train wagon crosses the alignment line. Measurements of equivalent and maximum noise levels (dBA) as well as sound pressure levels (dB) are performed. The background noise level is measured in order to establish the prevailing noise level.

Noise levels are determined by comparing the measurement results with the values of noise level limits specified in the Lithuanian Hygiene Standard HN 33:2007. According to HN 33:2007, the

maximum noise level in the residential area should not exceed 70 dBA in the day time, 65 dBA in the evening and 60 dBA at night. The equivalent noise level in the residential area should not exceed 65 dBA in the day time, 60 dBA in the evening and 55 dBA at night.

3. Noise investigations

When the noise was measured in the residential areas of Trakai in the day time, the equivalent noise level limit (NLL) was not exceeded in any of the measurement locations (Fig 3). The highest recorded equivalent noise levels were 61 – 64 dBA, but the noise level limit of 65 dBA was not exceeded. The lowest equivalent noise levels were recorded in the places that are further away from the main streets: at the measurement location 1.10 near the Vytautas the Great Gymnasium, which is within 100 metres distance from Vytauto street; at the measurement location 1.9, which is behind the parking lot of the night club “Salos”; at the measurement location 1.11 near the health centre “Trasalis” (within 80 m distance from Gedimino str.). The equivalent noise levels established at these measurement locations were 49 to 51 dBA.

The maximum noise level limit in the day time was exceeded by most at the measurement locations 1.3, 1.5, 1.8 and 1.13. At these measurement locations, the noise level limits were exceeded by 6 to 17 dBA. It was partly due to the fact that these measurement locations are near the crossroads of busy streets, besides, the distances from the measurement locations to the street were merely 8 to10 m.

The investigation showed that the maximum noise levels do not exceed the limit at the measurement locations that are further away from the streets (50 metres and more).

Exceptional noise test results in the evening were recorded at the measurement location 1.7 near the house No. 51 on Karaimų str. At this measurement location, the equivalent noise level was exceeded by 15 dBA and the maximum level by 23 dBA. This measurement location is within 50 metres from the crossroad of Trakų and Karaimų streets. It was also noted that the increase of traffic flow in the evening was 25 %, compared to the daytime. At other measurement locations, the noise level limit was exceeded insignificantly (1-3 dBA) or not exceeded at all (Fig 4).

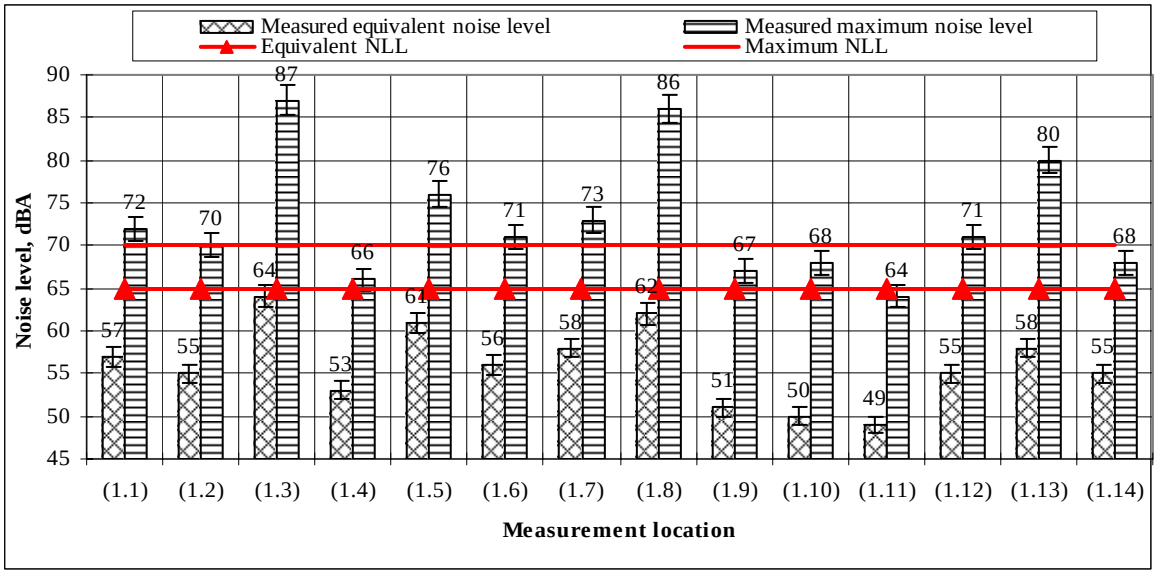

Fig 3. Equivalent and maximum noise levels in Trakai in the day time

At other measurement locations, the noise level limit was exceeded insignificantly (by 1-3 dBA) or it was not exceeded at all (Fig 4). When calculating the traffic flows, it was noted that the traffic flow in Trakai in the evening was increases by 25 % compared to the day time.

During the tests performed at night, it was established that the equivalent noise level limit is exceeded only at the measurement location 1.13 (Fig 5). The noise level limit was exceeded by 4 dBA. This measurement location is close to the roundabout on the way out of Trakai.

The lowest noise level was recorded at the measurement locations 1.4, 1.6, 1.9 and 1.11 and it was 45–47 dBA. It can be explained by the fact that the distance from the measurement locations to the street is more than 30 metres

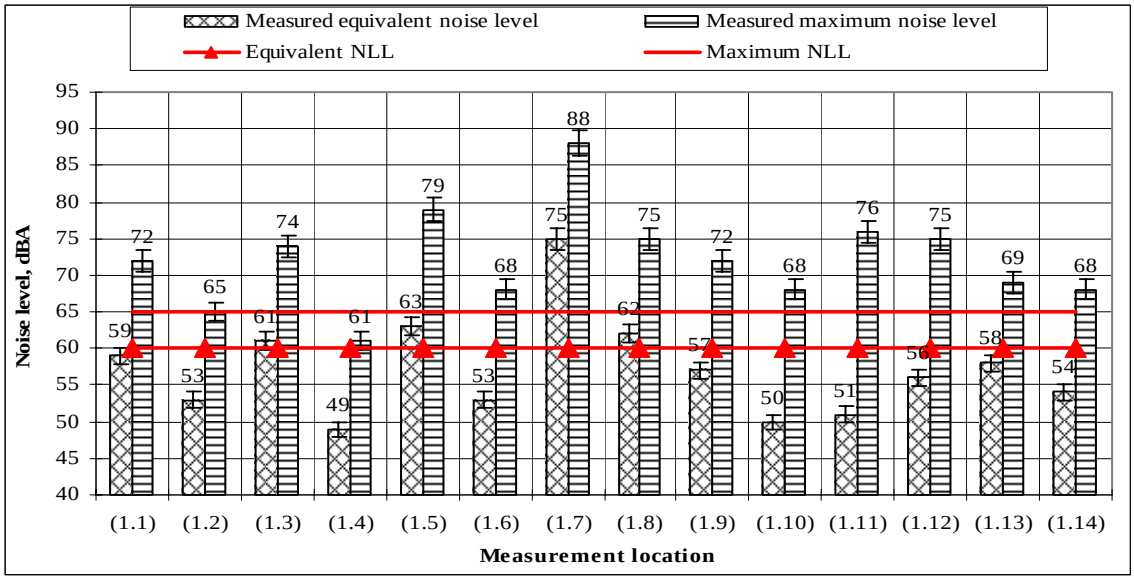

Fig 4. Equivalent and maximum noise levels in Trakai in the evening

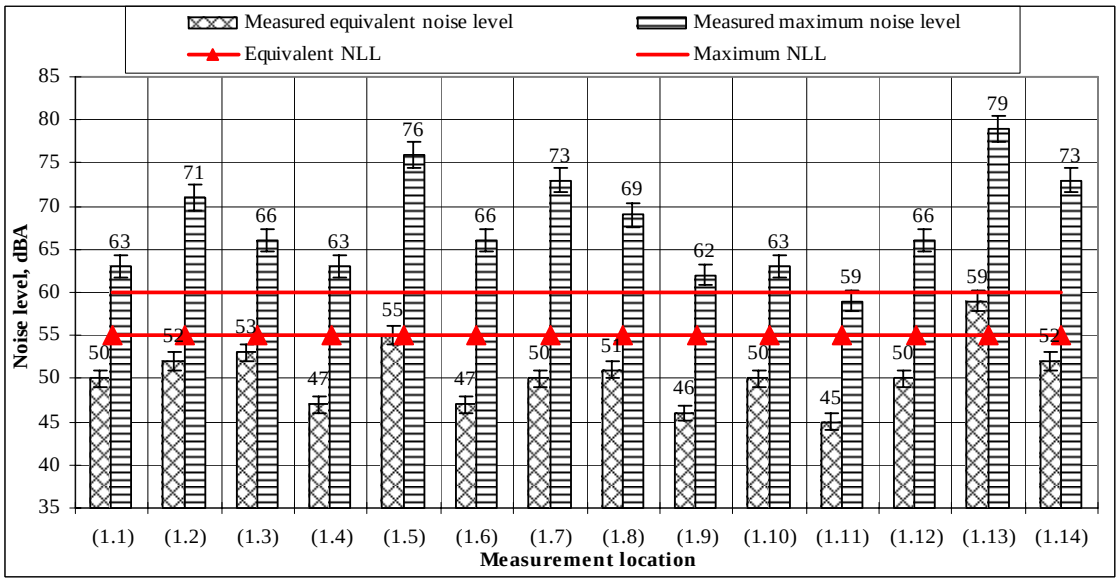

Fig 5. Equivalent and maximum noise levels in Trakai at night

Maximum noise level at night was exceeded at all measurement locations except 1.11, which is 80 metres away from Gedimino street. The maximum noise level limit was exceeded by most (11 – 19 dBA) at the measurement locations 1.2, 1.5, 1.7, 1.13 and 1.14. In other measurement locations NLL was exceeded by 2 to 9 dBA.

During the investigation of railway-generated noise near Trakai railway station (Vilniaus str. 5), it was established that railway-generated noise level at the measurement location 1.15 near the platform exceeds the equivalent noise level limit by 6 dBA. Meanwhile, the noise level of the same passenger train of 3 wagons measured within 100 metres distance from the railway station did not exceed the limit and was 57 dBA (Fig 6).

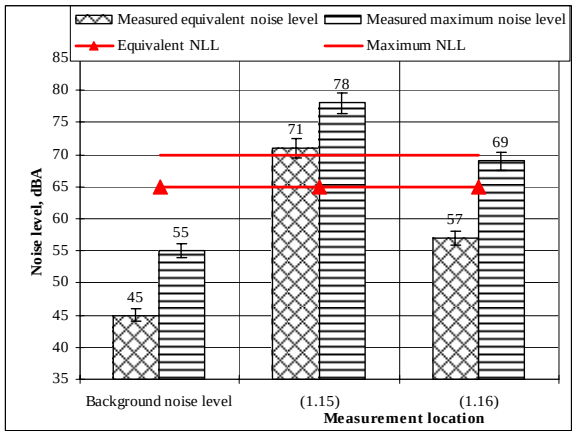

Fig 6. Equivalent and maximum noise levels at measurement locations 1.15 – 1.16 in the day time

The maximum noise level of a passenger train, which has just started off, exceeded the limit by 8 dBA. The background noise level near the railway station platform amounted to 45 dBA. It is partly due to the fact that this area is fenced from the busy Vilniaus street by gross and high trees and bushes.

The dynamics of the equivalent noise level in Trakai in the day time, in the evening and at night is presented in Fig 7. As has been mentioned, the equivalent noise level limit in the day time was not exceeded in any of the measurement locations except 1.15, where the railway-generated noise was measured. It was established that the equivalent noise level was exceeded at four measurement locations in the evening and at two locations at night. The equivalent noise level limit in the evening was exceeded by 1-3 dBA, except measurement location 1.7 near the crossroad of busy Trakų and Karaimų streets. At this measurement location, the equivalent noise level limit was exceeded by 15 dBA. The noise level limit at night was exceeded by 2-4 dBA at the measurement locations 1.3 and 1.13, which are close to busy streets.

The investigations showed that the highest noise levels are recorded in the day time and the lowest - at night. Higher noise levels in the day time and in the evening were recorded in the central part of the town, particularly at the places of interest where tourists gather.

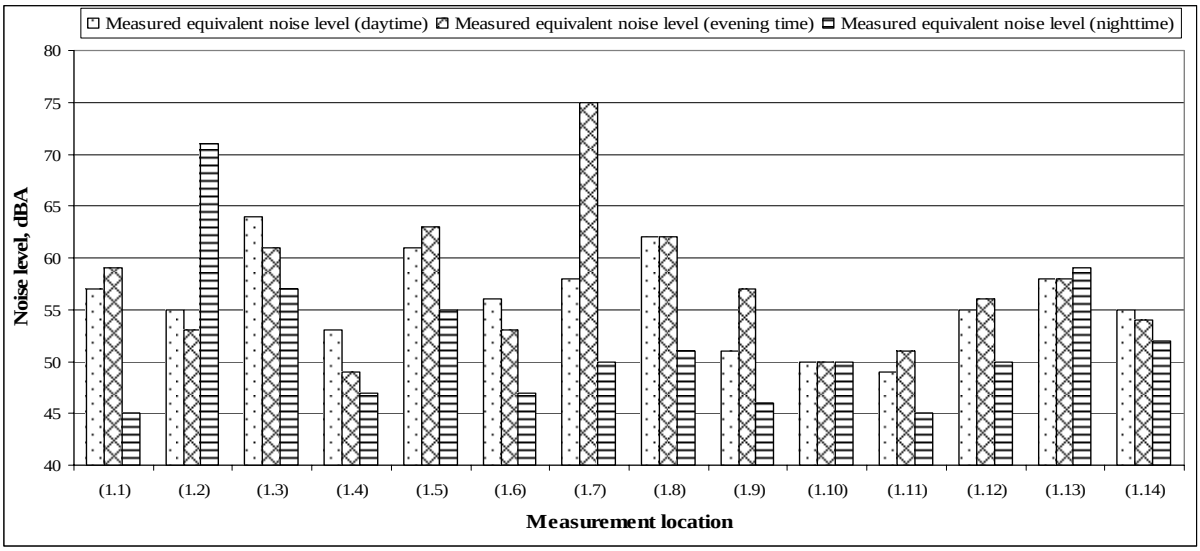

Fig 7. The dynamics of equivalent noise in Trakai in the course of 24 hours

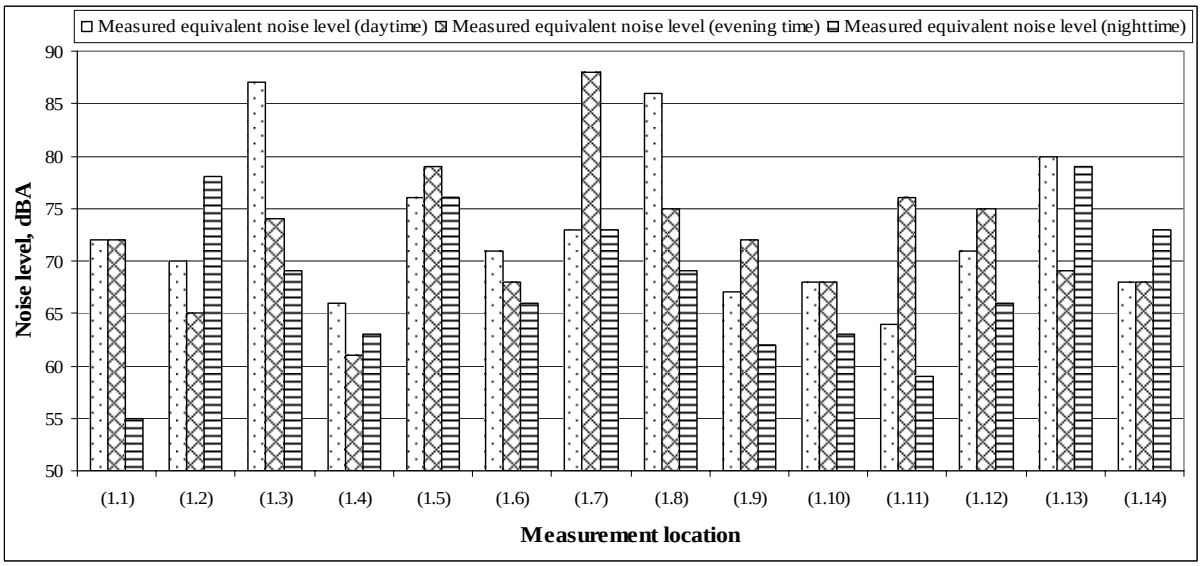

Fig 8. The dynamics of maximum noise in Trakai in the course of 24 hours

Unlike the equivalent noise levels, the maximum noise levels in the day time, in the evening and at night exceed the limits almost in all measurement locations. The maximum noise level was exceeded by up to 17 dBA in the day time, by 23 dBA in the evening and by 19 dBA at night. When the measurements were performed after 10 pm, i.e. when most of the people are resting, in 12 out of 14 measurement locations the maximum noise level limit was exceeded. At night, even the noise of a single technically disorderly car or one that is passing the empty streets at high speed disturbs the peace of many people. Therefore, in order to fight the transport noise at night, the speed should be limited in the main streets of the town. Besides, if possible, the traffic should be diverted around the central streets and residential districts at least at night.

4. Conclusions

1. It has been established that the equivalent noise level limit (NLL) in the day time is not exceeded at any of the measurement locations. The highest noise level has been recorded on Vytauto street near the shopping centre and it was 64 dBA.
2. The values of maximum noise level limits in the evening and at night are exceeded by up to 23 dBA at all measurement locations. At the measurement locations 1.3, 1.5 and 1.8 in the evening and at the measurement location 1.13 at night, even the equivalent noise level limit was exceeded.
3. Exceptional noise test results in the evening were recorded at the measurement location 1.7, which is within 50 metres from the crossroad of Trakų and Karaimų streets. At this measurement location, the equivalent noise level limit is exceeded by 15 dBA and the maximum level - by 23 dBA.
4. The noise tests performed at night showed that the equivalent noise level limit was exceeded by 4 dBA only at the measurement location 1.13, which is close to the roundabout on the way out of Trakai.
5. The lowest noise level at night has been recorded at the measurement locations 1.4, 1.6, 1.9 and 1.11, and it was 45-47 dBA. This can be explained by the fact that the distance between the measurement location and the streets is more than 30 metres.
6. The comparison of the noise levels at different times of the day showed that higher noise level was recorded in the evening and it was approx. by 1.2 dBA higher than the noise level recorded in the day time.
7. In order to resolve the problem of traffic-generated noise, it is necessary to limit the speed in the main streets of the town and arrange that the traffic was diverted around the central streets and residential districts.

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