TIORIR '11	INTEGRISANI MEĐUNARODNI SIMPOZIJUM – ISTI, ORRE i IRSE *INTEGRATED INTERNATIONAL SYMPOSIUM – ISTI, ORRE i IRSE* **September 11 – 15, 2011., Zlatibor, Hotel Mona**

MODELING OF NOISE IMPACT ASSESSMENT ON THE AGGREGATE SURFACE MINES

MODELIRANJE PROCENE BUKE NA POVRŠINSKIM KOPOVIMA KAMENA

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Abstract: *Noise as an integral part of modern life creates both psychological and physical problems. The biggest concern is the fact that despite the increase of noise, there is significant increase of the time of exposure on noise in living environment. The problem is particularly severe near the mine sites because large, noisy equipment dominates in the mining industry. This paper describes the process of noise analysis/modeling to assess the potential impacts of any proposed quarry to nearby urban and rural residential areas.*

Key words: *Noise, Impact, Criteria, Modeling*

Apstrakt: *Buka kao sastavni deo modernog života stvara psihološke i fizičke probleme. Zabrinjavajuće činjenice su da pored povećanja buke, postoji i značajno povećanje vremena izlaganja buci u životnoj sredini. Problem je posebno ozbiljan u blizini rudnika iz razloga što velika i bučna oprema dominira u rudarskoj industriji. U radu je opisan proces analize/modeliranja buke za procenu potencijalnih uticaja bilo kog kamenoloma u blizini urbanih i ruralnih sredina.*

Ključne reči: *buka, uticaj, kriterijumi, modeliranje*

1. INTRODUCTION

Dynamic mining industry with never ending need for increasing productivity lead to utilization of larger machinery in parallel with improvements in technology. Larger equipment usage has resulted in an increase in noise levels in all phases of mining production, starting from extraction to mineral processing plants. Powerful machines generate enormous levels of noise which easily spreads hemi-spherically in the free sound field.

As the mining sites and especially aggregate quarries are more often located (or surrounded) by a residential or other areas of public importance, it is become extremely important to make noise analysis to assess the potential noise impacts of new quarries, as much as to any proposed expansions or significant changes in technologies.

Noise impact assessment of usually include several phases as described below:

- Noise criteria
- Description of site conditions with special focus on operations location, noise receptors locations, background noise conditions, other important noise sources in vicinity of operations (industry, roads...) topography, meteorology.
- Description technology and mining equipment used (sound power calculations, locations over the project life time)
- Modeling,
- Noise impact analysis

The phases above are briefly elaborated on real example of proposed silica sand quarry expansion.

2. NOISE CRITERIA

Noise criteria or noise regulation setting, differ for specific country/territory. It must be mentioned that national regulations in Republic of Macedonia used in this case are fully in line with similar regulations of EU member countries.

The noise criteria used are defined according the provisions from:

- The low for environment protection ("Official Gazette of Republic of Macedonia No.79/07)
- Regulations for application of noise indicators, additional indicators of noise, method of measuring noise and methods of assessment indicators for noise in the environment ("Official Gazette of Republic of Macedonia No.107/08)
- Regulations for limits of the environmental noise levels (Official Gazette of Republic of Macedonia No147/08).
- Regulations for the locations of the measurement stations and measurement points ("Official Gazette of Republic of Macedonia" No.120/08).

The levels of the noise are directly identified with following indicators:

- L_d (Indicator for noise disturbance during the day) or daily noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987;
- L_e (Indicator for noise disturbance during the evening) or evening noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987
- L_n (Indicator for noise disturbance during the night) or night noise level which is A-equivalent long-term average sound level defined in ISO 1996-2:1987;
- L_{eq} (Equivalent noise level) is an indicator of the noise calculated from the measured noise levels in an interval.

In accordance with the Regulations for limits of the level of environmental noise, the limit value of basic indicators of noise in areas outside urban locations is defined as follows**:**

Table 1 Noise criteria according the types of regions

Types of regions	**Noise level in dB(A)**		
	L_d	**L_e**	**L_n**
Regions exposed to intense road traffic	60	55	50
Regions exposed to intense rail traffic	65	60	55
Regions exposed to air traffic	65	65	55
Regions with intensive industrial activity	70	70	70
Quiet areas outside agglomerations	40	35	35

Above mentioned regulation also define limit values of basic indicators of noise caused by different sources in urban areas**:**

Table 2 Classification of the zones in accordance with the level of noise protection

Zones defined in accordance with the level of noise protection	**Noise level in dB(A)**		
	L_d	**L_e**	**L_n**
First level zone (special protection zone include hospitals, schools ..)	50	50	40
Second level zone (residential areas only)	55	55	45
Third level zone (mix of residential and commercial zones, urban centers)	60	60	55
Fourth level region (industrial and other services zones)	70	70	60

The noise levels are defined either with measurements (background noise) or by modeling (proposed activity). As per this regulation “measurement” presents 24 hour continuous measurement of noise expressed by the noise indicator for day-evening-night (L) in decibels (dB (A)) which represents the average equivalent noise level for a day and night.

3. SITE CONDITIONS

Basis of the any noise impact assessment study is clear definition of the project boundaries with respect to sensitive receptors (residential areas, public infrastructure, recreational area…) and other industrial or servicing activities. Terrain configuration and weather conditions also have significant impact on transmission of sound.

Careful planning of operations development and usage of natural barriers will allow for implementation of mitigation measures in design phase which will ultimately reduce the noise impact of the project, thus helping its acceptability and reducing needs/costs of future mitigation measures.

The sample site is located in a shallow river valley opening to the north. About 1 km of the property north border, dense rural settlement is located, with some houses located within 300 m perimeter of the operations.

Figure 1 Location of sample site

Weather conditions are as usual quite variable even in 24 hours, so the data modeled are in favor of sound transmission to emulate worst case scenario which can lead to noise complains. The wind included in the model was 10 km/h from south (directed to the residential area), temperature 22^0 C, relative humidity 50% and no inversion.

4. MINE EQUIPMENT

Usually quarry operations introduce several noise sources to the project site, including heavy trucks on access roads, loading (loaders, bulldozers and shovels) and processing equipment (crushers and screens) and possibly power plant(generator sets). If blasting is used to break up the rock for hauling and processing, this could significantly add to the noise impact. In general, blasting is controlled to minimize dispersal of the rock fragments, and to ensure the safety of the workers. Blasting is also controlled to prevent damage to nearby structures, including any onsite construction. At the sample silica sand quarry blasting is not used and potential noise sources include:

- Bulldozer
- Front end wheel loader
- Mobile screen Plant
- Haul Trucks (30 tons)

Generic noise sources data for equipment used for modeling where derived from onsite measurements and historical data bases, and present solid base for noise dispersion prediction/modeling. Sound power levels for each noise source included in predictions are given in the table below.

Table 3: Sound power levels of noise sources in dB(A)

	Source	Total (dBL)	Total (dBA)
1	Bulldozer	109	104
2	Mobile screen plant	117	109
3	Front end loader loading trucks and mobile screen plant	107	101
4	30 tons haul trucks	97	91

Normal operation of the quarry is scheduled in 2 shifts starting from 6 am to 10 pm. Table 4 summarises operational times of each noise sources included in the modeling.

Table 4 Hours of operation for each piece of plant included in noise model

Noise Sources	**Day Time**	**Night time**
	6 am to 7 pm	**7 pm to 10 pm**
Bulldozer	✓	
Mobile screen plant	✓	
Front end loader loading trucks and mobile screen plant	✓	✓
30 tons haul trucks	✓	✓

5. NOISE MODELING

The final part of the project noise impact analysis for the proposed quarry expansion applied predicted noise levels and frequency content of representative noise sources to the Custic Noise Model (CNM).

Custic is a commercially-available noise propagation model that accepts input of noise levels and frequency content for a number of sources, located on a topographic base map of the project vicinity. The ENM then predicts noise propagation in term of noise contours, accounting for the effects of atmospheric and ground absorption of sound, and of the shielding provided by topography.

The CNM accounts for total atmospheric attenuation and barrier insertion loss by calculating the following individual attenuation components: geometric spreading, enclosures, barriers, air absorption, wind effects, temperature gradient effects, ground effects, shielding by vegetation and buildings.

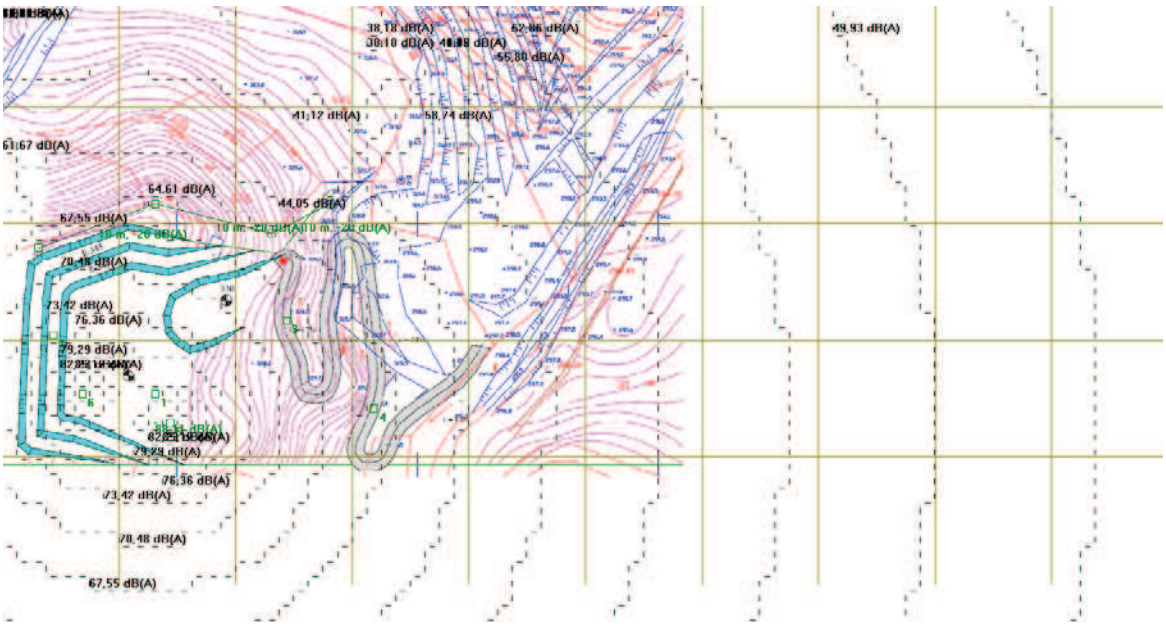

Figure 2 CNM screen presenting modeled noise contours

The results are summarised as follows for the 6am to 10pm time period:

- Southern catchment – Noise levels for night time are above the limits for in perimeter of 300 m but without sensitive receptors in the area.
- Eastern catchment – Noise levels are dominated by noise of haul trucks and although above the limits, there are no sensitive receptors in immediate vicinity
- North and Western Catchment – Due to topography (ridge to west and berms to north present natural barrier) so the noise levels are from 38 to 41 dB which is below the limit even for residential areas (II zone of protection).

6. CONCLUSION

The sound propagation calculation is undertaken using the Environmental Noise Model (ENM) noise propagation software package. ENM is an advanced noise propagation model that considers geometric spreading, atmospheric sound absorption, ground impedance effects, site topography, vegetation and environmental conditions.

Equivalent noise level information was used for the potential major noise sources that operated at the proposed quarry. The ENM model calculates the contribution level of each noise source at each receiver location as well as calculating the overall operation equivalent noise level in dB(A).

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