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Influence of Construction Activity on Academic Process

Augustina Tronac[a*], Dragos Dracea[a], Sebastian Mustata[a], Emilia Manole[a], Claudiu Dragomir[a], Nicolae Petrescu[b], Sevastel Mircea[a], Mariana Postamentel[a]

[a]*University of Agronomic Sciences and Veterinary Medicine of Bucharest, Bd. Marasti nr.59, sect.1, 011464 Bucharest, Romania*
[b]*Valahia University of Targoviste,Bd. Carol I nr.2, 130024 Targoviste, Dambovita County, Romania*

Abstract

In the context of execution of construction works close to an academic building, it was measured the sound level on construction site, near its enclosure, outside and inside the building, in different situations and equipment operation. The recorded values are compared to the values stipulated by legislation concerning the noise and conclusions are drawn regarding the regime of teaching activities during the execution period.

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Keywords: academic building, sound pressure level, noise national regulation, construction site

1. Introduction

We are constantly surrounded by the sounds and we can perform the work ignoring the background ones, those forming the environmental noise. As the noise intensity is amplified, it becomes a pollutant of life and work environment, which has health effects [5]: stress in relation to work, increased risk of accidents, physiological, effects, disruption of verbal communication, hearing loss, etc.

Noise impact can vary widely, depending on the distance from the point of reception and its nature, because some activities are sensitive to sounds. Perception of impact likely to result in discomfort, that interrupts the normal course of daily activities, is subjective, being a receptor personal factor.

* Corresponding author. Tel.: +40-788-523-056; fax: +40-213-176-003.
E-mail address: augustina.tronac@yahoo.com

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In compliance to the specialists in acoustics opinion, noise is an unwanted sound that interferes with verbal communication and auditory perception of affects human behavior, can reach to affect human health and activities. The decibel is a standard unit accepted for measuring sound levels cause to the fact that may be associated to large variations in sound pressure amplitude. When describing sound and its effect on human bodies, it is recommended to use sound levels "weighted A" – dB(A) in order to assess the response of the human ear. The term refers to a sound filtration in an appropriate manner by which the human ear perceives. The discomfort degree depends on the ambient noise level, the general nature of existing conditions (quiet/crowded areas, rural/urban areas), differences between event magnitude noise level and ambient noise conditions, sound event duration, season (open/closed windows, inside/outside activities), frequency and repeatability of noise event, time of day of producing it.

Appropriate sound level scale, corresponding to national noise regulations, connects typical sound pressure levels and limits legally established and it is presented in Figure 1 [2].

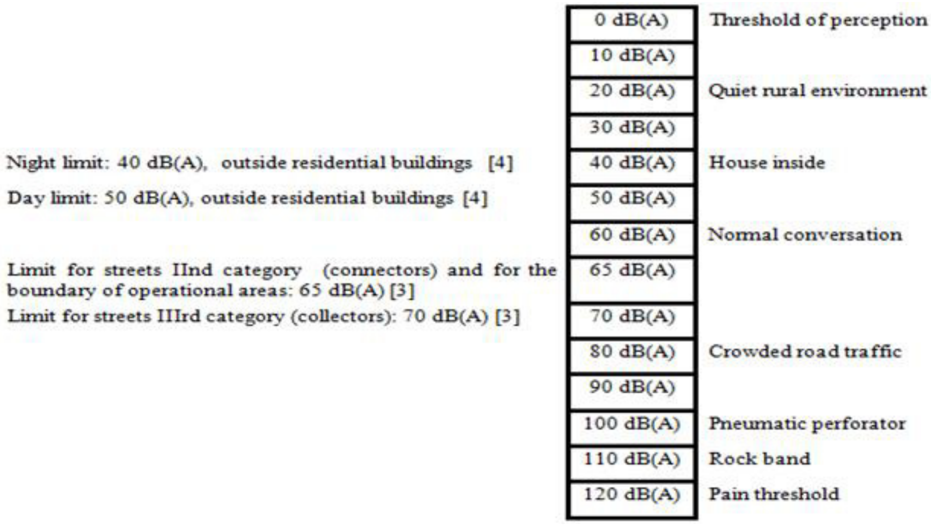

Fig. 1. Typical decibel scale and noise limits specified by national regulations.

In Europe, the population exposed to acoustic pressure above 65 db(A) is increasing, around 100 million persons suffering because of this problem [11].

Regulations in Romania [3, 4] stipulate limit values comparable to those of the EU or internationally as follows:

Table 1. Comparison of noise limits imposed by national and international standards [2].

Country/Region	Maximum allowable level, dB(A)		
	Industrial zones, day/night	Commercial zones, day/night	Residential zones, day/night
Romania	65	65	50/40
European Union (World Health Organization)	65	55	55/45
Australia	65/55	55/45	45/35
Japan	60/50	60/50	45/35
United States of America	70	60	45

Limit values set by the authorities are based on the sound effect on human health and take into account social and economic factors, varying by time of day, activity protected, type of noise source, etc. In this way it could be explained the differences between various national laws, elements considered being subjective.

In Romania, the legislation specified that is mandatory for any construction project to be accompanied by an environmental impact assessment, which includes a chapter analyzing the potential impact due to noise and mitigation measures [1].

2. Experiment description

It is analyzed a construction site of a building composed of basement and ground floor, designated to horticultural and agronomical experimental research and it is located inside a university campus. Construction of a storage building to maintain the existing technical basement and its superstructure demolition and reconstruction completed as project design. From the preparation work, that is the present stage, the technology of execution includes concrete breaking, loading, on site crushing and using the obtained materials to achieve site filling and land leveling.

The site is located in an area that has have permanent urban planning and development control, thereby all investments in higher education material basis obeyed these constraints. Zone boundary is close to residential buildings (contour wall of the campus) and educational buildings.

The relief is plan, the area is urbanized, buildings being rarified, located in an environment with dense vegetation on large surfaces; existing noise sources are due to the small road and pedestrian traffic and specific education activities noise (voices from groups of people), they having a well-defined daily periodicity: road traffic at the beginning and at the end of the program, pedestrian traffic and noise of voices at every class break).

Sources of noise impacts associated with construction activities include:

- Use of motor vehicles to transport materials and equipment to and from site
- Activities of excavation and disposal of excavated material
- Operation of mobile or stationary machines on the site, including trucks, excavators, crushers, bulldozers, loaders, emergency electric power generators

Noise receptors include workers an population outside the construction site boundaries (people living nearby buildings, student and teachers in adjacent educational spaces, visitors). It is intended to highlight the impact of noise on the normal conduct of education process, as it requires concentration and it is easily disturbed by impulsive noise, but it will be also considered the impact on contractor employees.

Please note that the space does not permit the establishment of buffer zones, and on the housing side, there is a limiter panel provided and there is in place a concrete wall having 2.5 m height.

To assess the impact of noise is necessary to make measurements or forecast of noise and comparing the values obtained with admissible limits as they were previously presented as a result of legislation. It was chosen the alternative of in situ measurements achievement, the normative being one that imposes performing conditions [8].

When measurements are needed in order to appreciate the noise for approaching human health issues, it is recommended to consider the sound pressure as a time independent element [12].

Measurements were carried out in real conditions, in accordance with standardized testing requirements [9]. They were conducted in open space, outside the construction site boundary fence (plastic mesh), within the construction site (near working equipment), and inside the building, in the lecture theaters located at ground floor and first floor, on the construction site side. It was made one set of measurements, on the daytime, air temperature being 25^0C and air relative humidity of 75% (standard conditions are 15^0C temperature and 70% relative humidity), 1.6 m/s wind speed, clear sky, bright sunshine. The measurement duration is of 10 seconds and is performed on the wind direction, thus the associated measurement uncertainty being minimal [8]. Shipyard area of earth, in dry state, the surrounding environment is of concrete, and they are representative for sound exposure conditions required by the test standard [9]. Measurements were performed at the proper distance from areas of interest, taking care not to interfere elements with major contribution in sound propagation.

Measurement point locations are those in Figure 2.

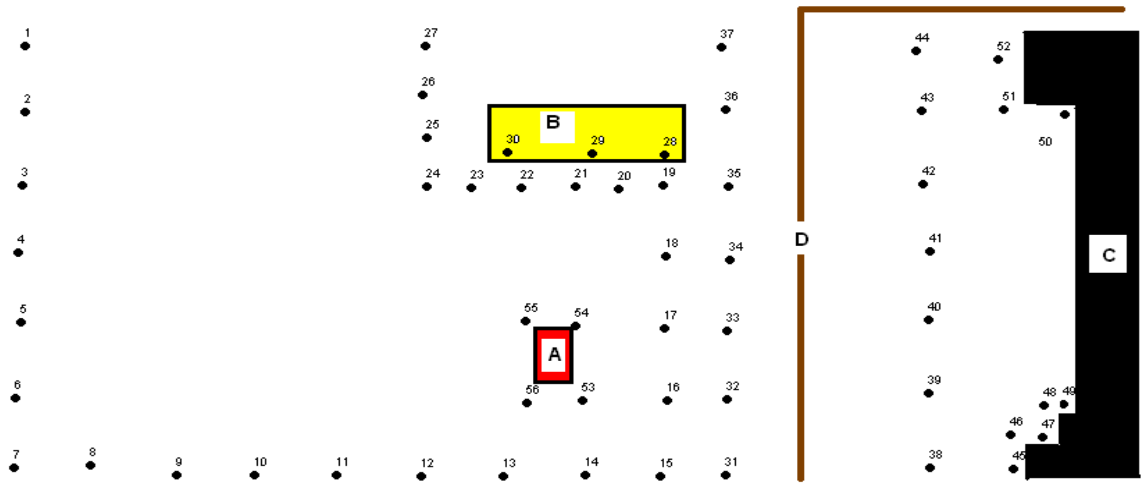

Fig. 2. Sound pressure measuring points (A – crusher, B – greenhouse, C – academic building, D – parking wall).

The equipment used is a Chauvin Arnoux sound level meter (CA 834) with measuring range of 30-80 dB, 50-100 dB, 80-130 dB and measurement extended range of 30-130 dB.

Cumulative measurements were made for stationary machines and linear sources (vehicles) to obtain an image of the impact due to ambient noise sources involved in the project. The values obtained documented in the form of data tables and contour lines maps for activities generating noise in representative time moments of execution technology.

In this stage of execution, there are typical equipments for material handling (excavators, dozers, loaders) plus pick-hammer and crusher, due to constructive solution chosen described above. The machines are equipped with internal combustion engines for propulsion and actuation of working mechanisms. Engine sounds are dominating other acoustic emissions, of which the most important is the exhaust, followed by the inlet and structural parts movements. Other noise sources are mechanical and hydraulic transmissions and driving systems, as well as cooling fans [2].

Normal operating cycle consists of periods of running t full power of 102 minutes long, followed by periods of 3-4 minutes long with less power. This variation of power in normal operation will cause variable noise emission, although not necessarily linearly related. To take into account for these variations in power and noise emission, in the analysis and modeling it should be applied an adjustment factor of power of about -4 dB(A) at the maximum power classes for mostly stationary equipment [2].

According to specifications, mechanical and acoustic powers for the machines used are shown in table 2 [10].

Table 2. Characteristics of equipment used in activities.

Equipment	Mechanical power	Acoustic Power (LwA)
	kW	dB(A)
Crawler dozer CAT D6K2	97	109
Hydraulic excavator PC130	68.4	100
Wheel loader WA200PZ-6	94	104
Crusher BR380JG-1	140	92
Hydraulic pick-hammer HPP09+HH20	9	100

For the pick-hammer and the crusher, the maximum power is associated to mechanisms working situation and not engine functioning, the operating cycle having the same steps as for earthmoving machines.

3. Results and significances

Measurements were made in 2 variants:

- When material handling equipment are working (variant 1)
- When material handling equipment and crusher are in operation (variant 2).

For a few points it could be made a measurement surprising pick-hammer's operation, it is representing an isolated sound event for the ongoing technological stage.

The values obtained are presented in Tables 3 and 4.

Table 3. Values recorded outdoor (var.1 – without crushing; var.2 – with crushing).

Points	Acoustic pressure dB(A)			Points	Acoustic pressure dB(A)		
	Var.1	Var.2	Comments		Var.1	Var.2	Comments
1	66.1	72.0	Behind site fence	29	79.3	67.2	21 – safety membrane
2	66.6	72.5	Behind site fence	30	76.4	68.2	23 – safety membrane
3	69.0	72.4	Behind site fence	31	65.7	67.4	Behind site fence
4	66.5	69.6	Behind site fence	32	62.7	72.5	Behind site fence
5	66.4	69.9	Behind site fence	33	62.2	70.3	Behind site fence
6	65.8	67.3	Behind site fence	34	61.4	72.6	Behind site fence
7	63.6	67.0	Behind site fence	35	69.5	66.4	Behind site fence
8	63.1	66.8	Behind site fence	36	59.4	66.4	Behind site fence
9	66.3	72.1	Behind site fence	37	59.4	66.7	Behind site fence
10	62.8	63.1	Behind site fence	38	59.1	66.0	Behind site fence
11	71.1	72.5	Behind site fence	39	59.0	65.0	Behind site fence
12	74.0	80.1	Behind site fence	40	60.2	64.2	Behind site fence
13	77.0	86.6	Behind site fence	41	59.2	65.1	Behind site fence
14	77.2	86.9	Behind site fence	42	57.0	64.6	Behind site fence
15	76.3	82.0	Behind site fence	43	55.9	63.6	Behind site fence
16	82.7	80.0	Behind site fence	44	56.9	64.0	Behind site fence
17	84.5	81.2	Behind site fence	45	58.5	64.0	Behind site fence
18	76.6	80.8	Behind site fence	46	57.2	67.7	Behind site fence
19	79.9	82.1	Behind site fence	47	58.5	62.9	Behind site fence
20	81.5	76.3	Behind site fence	48	57.9	61.1	Behind site fence
21	80.5	76.3	Behind site fence	49	58.2	63.9	Behind site fence
22	72.7	79.0	Behind site fence	50	56.2	66.4	Behind site fence
23	72.1	73.2	Behind site fence	51	59.0	63.8	Behind site fence
24	70.4	72.0	Behind site fence	52	57.5	63.6	Behind site fence
25	66.7	69.1	Behind site fence	53	87.0	91.3	Crusher
26	65.5	66.3	Behind site fence	54	81.0	88.0	Crusher
27	73.1	75.5	Behind site fence	55	76.5	83.3	Crusher
28	79.4	74.6	19 – safety membrane	56	87.7	91.7	Crusher

Table 4. Values recorded inside academic building.

Points	Acoustic pressure dB(A)		Points	Acoustic pressure dB(A)	
	Windows closed	Windows open		Windows closed Var.1/Var.2	Windows open Var.1/Var.2
57	36.3	42.4	61	36.2/43.0	40.1/47.3
58	33.2	40.5	62	47.3/50.5	50.2/54.1
59	33.2	37.0	63	31.2/32.2	31.4/35.2
60	28.4	30.3	64	32.1/33.0	41.8/49.2

Also, some measurements have been carried out behind a safety membrane of 1 mm thickness, in order to reveal its ability to reduce noise

The results were used for graphical representation, and thus can lead to define noise impact areas with values greater than relevant legislation provisions.

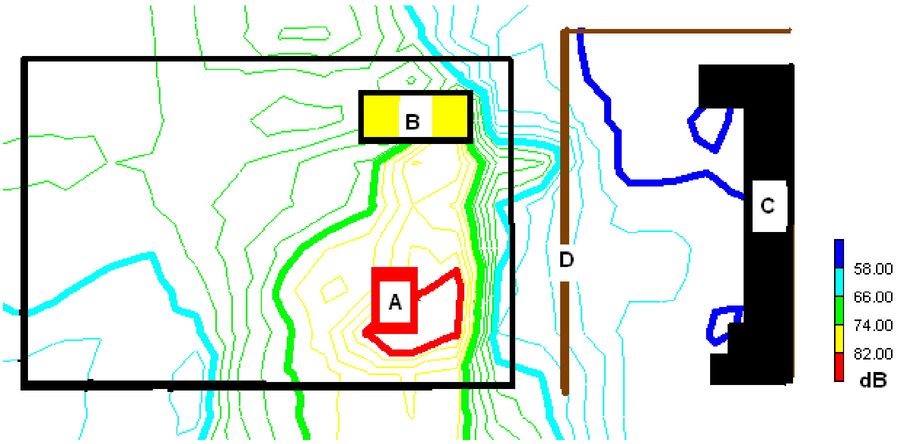

Fig. 3. Contour lines – Variant 1.

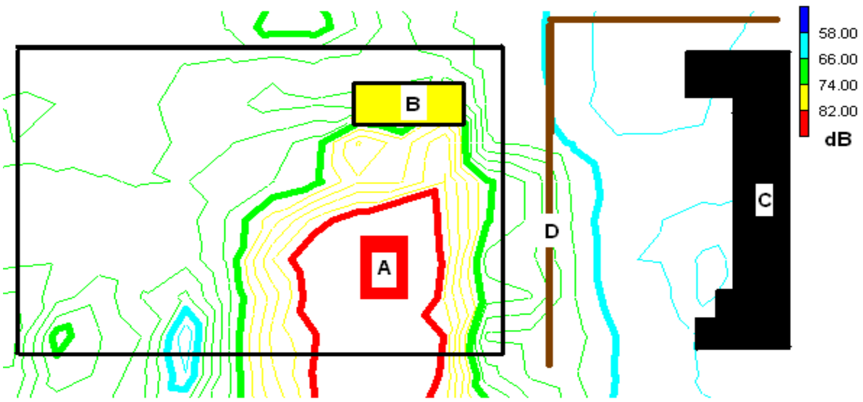

Fig. 4. Contour lines – Variant 2.

Presented data are interpreted as follow:

- In all outside measuring points, in any variant, day limit value outside residential buildings, of 50 dB(A) is exceeded
- For measurement points inside the academic building, the value of 50 dB(A) is isolated exceeded
- Excepting 3 (three) measuring points, in the yard area the registered values exceed the limit corresponding to streets IInd category (connectors) and boundary of operational areas, of 65 dB(A)
- Points located on the boundary, approximately equidistant to the crusher (points 12-24), have registered values between 70.4 dB(A) and 84.5 dB(A) – in variant 1, and between 72.0 dB(A) and 86.6 dB(A) - in variant 2
- Near the crusher the limit value corresponding to streets IIIrd category (collectors), of 70 dB(A), is exceeded even in the case when noise is produced by the crusher engine only
- In the moment of crushing it is observed an increase of sound pressure value of about 0,4% to 18.4%
- Behind parking wall (1.5 m high) all sound pressure values are below 65 dB(A), limit characteristic for streets IInd category (connectors) and for the boundary of operational areas, lower approximately 12% compared to variant 2 and 19% compared to variant 1
- Where measurements inside building, there was a variation of 3% up to 18.8% between variants, when windows were closed and a variation of 8% to 18% between variants when windows were open
- Comparing values registered at the same coordinates, inside and outside, it is found that when open windows, in variant 1 differences occur from 37.6% to 90% and in variant 2, differences from 12.9% to 86%; when closed windows, in variant 1 appear differences from 22.4% to 102% and in variant 2, differences from 21% to 108.5%
- In variant 1, differences between the situations with open windows and with closed windows are from 6.7% to 20% at the ground floor level and from 0.6% to 30.2% on the first floor
- The pick-hammer use leads to sound pressure augmentation of 19% in variant 1 and of 12% in variant 2.

4. Conclusion

- For all points on the perimeter or within the construction site (points 1-27 and 53-56) values are greater than 60 dB(A), meaning that the noise is higher than normal conversation level; in most measurement points the sound pressure level exceeds the limit allowed by law for streets IInd category (connectors) and for the boundary of operational areas, of 65 dB(A) [3]
- For all points located on exterior wall of academic building observed (points 42-52) values are superior, in any variant, to the day limit provided by Romanian legislation outside residential buildings, of 50 dB(A) [4]
- For modeling the efficiency of sound insulation was used a safety membrane of 1 mm thickness (plastic), and the values show a decrease of about 5 dB(A), representing a variation of 4%-10%
- Windows have a very important sound insulation effect proved by measurements made, of approx. 20%, meaning 15 dB(A)
- When windows are open registered values rise at crusher in operation, even above the day limit imposed by law for outside residential buildings, of 50 dB(A)

This means that during the use of crusher and pick-hammer, the educational activity can take place only with the windows closed and, as the construction is accomplished during warm period of year, it is necessary to exist and to be functioning air conditioning systems to supply ventilation.

References

[1] Guvernul Romaniei, Ordin al Ministrului Apelor si Protectiei Mediului nr.863/26.09.2002 privind aprobarea ghidurilor metodologice aplicabile etapelor procedurii cadru de evaluare a impactului asupra mediului, Anexa II.2 "Structura raportului studiului de impact asupra mediului", Bucuresti, 2002 (Government of Romania, Ministry of Water and Environment Protection Order no.863/26.09.2002 approving the methodological guidelines for stages of framework procedure of environmental impact assessment, Appendix 2.II "Structure o Environmental Impact Assessment Report", Bucharest, 2002) .

[2] Rosia Montana Gold Corporation, Raport la studiul de evaluare a impactului asupra mediului, Cap.4.3. Zgomot si vibratii (Rosia Montana Gold Corporation, Report to the Study of Environment Impact Assessment, Cap.4.3. Noise and vibration), available at: www.rmgc.ro/Content/uploads/uploads_eia/impactul-potential/zgomot-vibratii/04.3-zgomot-si-vibratii.pdf

[3] Asociatia Romana de Standardizare - ASRO, STAS 10009-88, Acustica urbana: Limitele admisibile ale nivelului de zgomot, Bucuresti, 1988, (Romanian Association for Technical Standards – ASRO, STAS 10009-88, Urban acoustics: Permissible limits of noise level, Bucharest, 1988).

[4] Guvernul Romaniei, Ordin al Ministrului Sanatatii nr.536/1997 pentru aprobarea Normelor de Igiena si a recomandarilor privind mediul de viata al populatiei, Bucuresti, 1997 (Government of Romania, Ministry of Health Order no. 536/1997 for the approval of Hygiene Rules and Recommendations on the population's living environment, Bucharest, 1997).

[5] L. Rapas, Y. Corha, Protejarea sanatatii si prevenirea imbolnavirilor asociate expunerii la zgomot – program de supraveghere derulat in perioada 2002 – 2005 in Municipiul Bucuresti, Directia de Sanatate Publica a Municipiului Bucuresti (L. Rapas, Y. Corha, Protecting health and preventing diseases associated with noise exposure – surveillance program carried out during 2002-2005 in Bucharest, Public Health Department of Bucharest), available at: www.slideserve.com/sanura/protejarea-sanatatii-si-prevenirea-mbolnavirilor-asociate-expunerii-la-zgomot-program-de supravegheree-derulat-n-peri

[6] M. N. Andronescu, N. Tariceanu, M.L. Chitu, Managementul zgomotului in santierele de constructii (M. N. Andronescu, N. Tariceanu, M.L. Chitu, Managementul zgomotului in santierele de constructii, Management of noise in construction sites), available at: www.google.ro/url?sa=t&rct=j&q=&esrc=s&source=web&cd=3&ved=0CDsQfjAC&url=http%3A%2F%2Fzgomot.protectiamuncii.ro@2Focs%2Fgalati2FAndrones.

[7] Monitorul Oficial al Romaniei nr.19/10.01.2008, Hotarire nr.312 din 14.04.2005 (republicata) privind evaluarea si gestionarea zgomotului ambiental, Bucuresti, 2008 (Official Gazette of Romania no.19.10.01.2008, Decision no.321 of 14.04.2005 (republished) on the assessment and management of environmental noise, Bucharest, 2008).

[8] ASRO, SR ISO 1996-1:2008, Acoustics – Description, measurement and assessment of environmental noise – Part 1: Basis quantities and assessment procedures, Bucharest, 2008.

[9] ASRO, SR ISO 1996-2:2008, Acoustics – Description, measurement and assessment of environmental noise – Part 2: Determination of environmental noise levels, Bucharest, 2008.

[10] Directive no.2005/88/EC of the European Parliament and of the Council of 14 December 2005 amending Directive no.2000/14/EC of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors

[11] V. Nedeff, E. Mosnegutu, C. Tomozel, A. Pal, F. Samoila, Design and implementation of a fixed system for video-acoustic monitoring of urban noise pollution, Annals of DAAAM for 2012& Prodeedings of the 23rd International DAAAM Symposium, Vol.23, No.1, ISSN 2304-1382 ISBN 978-3-901509-91-9, CDROM version, Ed.B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2012, available at: http://www.daaam.info/Downloads/Pdfs/proceedings/proceedings_2012/0835_Nedeffatal.pdf

[12] M. Badida, P. Herczner, J. Konkoly, E. Lumnitzer, Formalization of a methodology for measuring of the noise from small sports airports, Annals of DAAAM for 2011& Prodeedings of the 22rd International DAAAM Symposium, Vol.22, No.1, ISSN 1726-9679, ISBN 978-3-901509-83-4, Editor B. Katalinic, Published by DAAAM International, Vienna, Austria, EU, 2011, available at: http://www.daaam.info/Downloads/Pdfs/Proceedings/proceedings_2011/p26391d1Hercznerl.pdf