

**XV International Conference Noise Control 2010**

**Abstracts**

**1. Methodology of identification of characteristics of significant sources of noise emission from areas of mining and power plants**

AUGUSTYN Aneta, aaugustyn@komag.eu

KOMAG Institute of Mining Technology  
Pszczyńska 37, 44-101 Gliwice, Poland

Noise is a very harmful factor and necessity of its reduction results from negative effects that it causes. Regulations as regards reduction of over-standard noise emission are included in legal requirements, which are in force. Power plants are significant sources of sound exceeding permissible levels. High level of acoustic power in a wide frequency range is their characteristic feature. They have considerable impact on creation of acoustic climate in the neighbouring areas, what requires reduction of over-standard noise emission. Proper identification of significant noise sources and selection of parameters of noise reduction measures are possible to be realized more accurately when noise emission uncertainty is reduced and, additionally, noise is identified in a function of changes of turbogenerator's load.

The paper is a trial of explanation of currently used methods for identification of noise sources and determination of acoustic field. The method of realization of analyses of acoustic field of power plants, alternative to classic one, was suggested. Validation of testing methods that are in force was conducted.

\* \* \*

**2. Assessment of teachers' exposure to noise in primary schools**

AUGUSTYŃSKA Danuta, daaug@ciop.pl

KACZMARSKA Anna, MIKULSKI Witold, RADOSZ Jan

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Assessment of teachers' exposure to noise in primary schools was carried out on the basis of: questionnaire studies (covering 187 teachers in 3 schools), noise measurements

at the teachers' workplaces, measurements of the school rooms acoustic properties (reverberation time, speech transmission index STI), analysis of statistical data regarding hazards and occupational diseases in the education sector. The studies have shown that noise is the main factor of annoyance in school environment. Over 50% of questioned teachers consider noise as annoying and near 40% – as very annoying or unbearable. *A*-weighted equivalent continuous sound pressure levels measured in classrooms, teacher rooms, common rooms, are in the range of 58–80 dB and they exceed 55 dB (criteria of noise annoyance). The most frequently reported subjective feelings and complaints (over 90%) are: growth of psychical and emotional tension, irritation, difficulties in concentration, hoarseness, cough. Noise in schools is also a harmful factor. High *A*-weighted equivalent continuous sound pressure levels ranging 80–85 dB, measured in corridors during pauses and in gymnasiums, may cause the risk of hearing damage among the PE teachers and persons oversensitive to noise. The latter concerns both the teachers and pupils. High background noise levels (55–65 dB) force the teachers to raise their voice. It can lead to the development of an occupational disease – chronic voice disorders due to excessive vocal effort, lasting for at least 15 years. In the education sector 785 new cases of this disease were reported only in 2008. Poor acoustics in classrooms (reverberation time ranging from 0.8 to 1.7 s, STI < 0.6 in 50% of classrooms) have an adverse influence on speech reception and make the teaching and learning processes difficult.

\* \* \*

### 3. Low cost sound level meter based on LabView

BARAŃSKI Robert, robertb@agh.edu.pl

AGH University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

Nowadays technical possibilities to build and implement new solution in industry or scientists research are very wide. PC computer with dedicated environmental software makes building equipment previously reserved to FPGA systems possible. In this article we focus on building a low cost sound level meter provided with many features like third octave or octave analysis. The main reason to undertake this problem was teaching. In Mechanics and Vibroacoustics Department every year we teach tens students with a few devices (like SVAN 948). Now every student can prepare to laboratory classes individually.

To build the system we have used laptop computer with integrated music card and low cost microphone. All algorithms were implemented in LabVIEW 8.6, thus we call our system SLM\_LV\_v1.2c.

In testing SLM\_LV\_v1.2c we made calibration procedure in Vibroacoustics Laboratory place on Mechanics and Vibroacoustics Department (Calibration Laboratory accredited in Polish Centre for Accreditation). On the basis of the research the sound level was almost 1 class (only one requirement has not been met). The main conclusion is that the system built on PC class computer and low cost microphone can be used for a sound level indicator.

\* \* \*

#### 4. Numerical uncertainty in processes of acoustical monitoring

BATKO Wojciech, Batko@agh.edu.pl

AGH – University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

The subject of the article is the problem of uncertainty of control assessment in processes of monitoring of environmental acoustical hazards. The uncertainty budget for processing of measurement data in systems for environment monitoring is presented. A special concern is paid to the problem of numerical errors generated by decibel arithmetic used in procedures of processing of monitored values. Also the need of modification of mutual bounds between those values is defined and the suggestion for solution is presented. An analysis is made for estimation calculation errors for existing estimation procedures of noise hazards. The presented consideration were supplemented by references to the results of monitoring of noise in the work stands and to the assessments used in solutions of monitoring systems for acoustical hazards in environment.

\* \* \*

#### 5. New ideas of solutions in building of monitoring systems for noise hazards in environment – construction examples

BATKO Wojciech, Batko@agh.edu.pl  
BORKOWSKI Bartłomiej, bborkow@agh.edu.pl  
GŁOCKI Krzysztof, glocki@agh.edu.pl

AGH – University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

The article presents a new idea of construction of a monitoring system for acoustical hazards in environment, emerging from its tasks and role in the legal requirements of noise directive 2002/49/EC, dedicated to development and application of strategic acoustic maps. They generate certain requirements for available solutions of acoustic monitoring stations and their instrumental control and record circuits for the acoustic hazards in environment. The requirements include the need for their compact integration with the systems for monitoring of non-acoustic data and fulfilling the role of control unit for their processing. For meeting of the aforementioned functions, a functional structure was developed for ensuring of openness for cooperation with the systems of monitoring of parameters: weather, road traffic, railway traffic or air traffic, and with the systems of vision identification and location identification as well as their cooperation with information technologies such as GIS. Also the discussion includes the conditions of coordination of their tasks and the method of their transfer to the relevant information channels, with high degree of spatial distribution and the application of IT tools for acquisition and processing of the acoustic and non-acoustic data, necessary in assessment of acoustic climate of the environment, with possibly minimal engagement of human factor in the control process. The need for application of algorithms of automated data processing was stated and also the need for development of analysis algorithms for multidimensional data sets, including the algorithms of prediction of monitored changes, filtration of measurement errors, with pointing to the place of their application in the

proposed solution. The attention is paid to the functional safety of the central storage of measurement data and the use of Open Source tools in the realized construction of the system.

The article presents the results and conclusions from numerous researches in exploitation of new type of solution. Further possibilities of their application were also shown considering their current stage of technological and methodical development in the area of their application, for development of strategic acoustic maps and search for the possibilities of detection of sources of noise hazards.

\* \* \*

## **6. New approach to uncertainty assessment of acoustic effects in the environment**

BATKO Wojciech, batko@agh.edu.pl

PAWLIK Paweł, pawlik@agh.edu.pl

AGH University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

Assessment of the acoustic climate needed for solutions (technical, legal and organisational) aimed at minimising acoustic inconveniences in the analysed regions is being realised mainly on the basis of acoustic maps. Those maps – in turn – are based on the appropriate calculation models. The reference calculation algorithms assigned to them, require a thorough preparation of initial data for the noise source model, which would describe acoustic excitations in the best way. Selection of the appropriate values – from a certain interval of their possible variability – is difficult and charged with multiple errors, in this class of tasks. These conditions are directly correlated with the uncertainty of acoustic maps.

The idea of applying the interval arithmetic into the uncertainty assessment of acoustic models was formulated in the present paper. A computational formalism assigned to the interval algebra was described. The rules of estimating intervals for model solutions, describing the sound level distribution around the analysed sound source caused by possible errors committed in determining the initial data, were presented. Application of these data in the uncertainty assessment of modelling of acoustic effects of a linear source railway noise in the environment – was illustrated.

\* \* \*

## **7. Development and validation of a numerical prediction model to estimate the annoyance condition at the operation station of compact loaders**

CARLETTI Eleonora, e.carletti@imamoter.cnr.it

PEDRIELLI Francesca, CASAZZA Camilla

IMAMOTER Institute – National Research Council of Italy  
Via Canal Bianco, 28  
44124 Cassana (Ferrara) – Italy

Traditional noise control engineering methods are focused on reducing the emitted *A*-weighted sound pressure level in order to meet the legislative requirements. Unfor-

tunately, the only reduction of this level does not guarantee a real improvement of the acoustic comfort.

On the other hand, the application of the Sound Quality approach aimed at obtaining other parameters most related to the subjective perception of annoyance, requires subjective listening tests which are very time-consuming. For this reason, earth moving machine manufacturers would benefit from a prediction model able to assess the annoyance condition at the operator station, simply on the basis of objective characterizations of the noise signals.

This paper describes the results of a study aimed at developing and validating such a prediction model, which can be used to assess the annoyance condition at the workplace. For this purpose, binaural measurements were carried out at the operator station of three different loaders during several repetitions of the same working cycle, performed with two different materials (gravel and loam). The recorded sound stimuli were objectively analyzed in terms of acoustic and psychoacoustic parameters and used in specific jury tests in order to assess the subjective annoyance.

A prediction model of annoyance was then developed following the multiple regression technique. This model was finally validated by using noise stimuli recorded at the operator position of some other loaders in work conditions.

\* \* \*

## **8. Sound, noise and speech at the 9000-seat Holy Trinity Church in Fatima, Portugal**

CARVALHO António P.O., carvalho@fe.up.pt

SILVA Pedro M.A.

University of Porto

Faculty of Engineering

Laboratory of Acoustics

Rua Dr. Roberto Frias, 4200-465 Porto, Portugal

This paper presents the interior acoustical characterization of the 9,000-seat church of the Holy Trinity in the Sanctuary of Fátima, Portugal, inaugurated in 2007. *In situ* measurements were held regarding interior sound pressure levels (with and without the HVAC equipment working), NC curves, RASTI (with and without the installed sound system) and reverberation time. The results are presented and commented according to the design values.

A comparison is made with other churches in the world, also with a very large volume (for instance the Basilica Mariacka in Gdańsk). The measured data are also used to calculate a global index of this church acoustic quality using Engel's and Kosała's Index Method.

\* \* \*

## 9. Assessment and reduction of noise levels on Roumanian oil drilling and production platforms operating in the black sea

CIOCA Lucian Ionel<sup>1</sup>, lucian.cioca@ulbsibiu.ro  
MORARU Roland Iosif<sup>2</sup>, roland\_moraru@yahoo.com  
PLATON Silviu Nicolae<sup>3</sup>, silviuplaton@yahoo.com

<sup>1</sup> University "Lucian Blaga" Sibiu,  
4, Emil Cioran str., 550025 Sibiu, Roumania

<sup>2</sup> University of Petroșani Romania,  
20, University str., 332006, Petroșani, Roumania

<sup>3</sup> I.N.C.D.P.M. București  
The National Institute for R&D on Occupational Health and Safety  
35A, Ghencea Bld., sector 6, 061692 Bucharest, Roumania

Since 1975, when the first Roumanian drilling platform, Gloria, started operation in the Black Sea, the national legal and regulatory framework have dramatically changed, mostly after 2006, when the entire occupational health and safety legislation was harmonized with the European Directives. The need to comply with the new constraints concerning the noise control on the drilling and production platforms operated by the largest Roumanian company in the field, required a systematic and coherent campaign of measurements, aimed primarily at noise levels assessment. Using the state-of-the-art equipment, measurements were carried out on eight drilling and production platforms, determining noise levels in specific locations, such as compressors, turbine engines, donkey boilers, crude oil pumps and cooling pumps, separation devices but also in camp facilities. Outlined in the paper, the data obtained have revealed that the highest number of noise sources which are exceeding maximum allowable limits are located on the Fixed Central Production Platform, where the entire oil and gas output from the tide land is concentrated, before being directed towards the terminal on shore. Sound-meters and dosimeters were then employed to assess noise levels, both in the working environment and in the purpose of assessing the worker's occupational discomfort. The spectral analysis determinations for 23 different noise sources are also highlighted in this paper, together with some of the technical and organizational measures for noise level reduction and monitoring, the measures which are already implemented as a result of this two years duration study.

\* \* \*

## 10. Deliberations on a vibroacoustic axiom

DĄBROWSKI Zbigniew, zdabrow@simr.pw.edu.pl  
Warsaw University of Technology  
Faculty of Automotive and Construction Machinery Engineering  
The Institute of Machine Design Fundamentals  
Narbutta 84, 02-524 Warszawa, Poland

Every distinguished scientific field, in order to deserve such name, has to satisfy certain basic conditions. These are:

1. Well determined research zone;
2. Axiom (preliminary assessments, fundamentals of empirical knowledge);
3. Deductive system allowing for drawing *a priori* and *a posteriori* conclusions.

Vibroacoustics was created to realise the demand of considering jointly noises and mechanical vibrations as similar forms of the energy – the most often parasitic – propagation (though sometimes this energy is utilized in vibratory machines) however constituting the valuable information source on the object condition. Thus, in a natural way, from the very beginning of its being the vibroacoustics constituted a connection of the theory of vibrations and acoustics – two well defined fields of knowledge. But such fact is not enough to state that this is a new science. Both, the theory of vibrations and the theoretical acoustics are distinguished branches of physics (mechanics), where drawing conclusions is based on the differential equation language (ordinary and partial). Attempts to ‘connect’ them do not bring any new value, apart from the statement that the researcher – who wishes to deal with the environmental impact of vibrations and noises of machines – should be highly conversant with both theories. Thus, the distinct vibroacoustics subject requires at least a different approach to the research results of both fields (sometimes used on purpose). Such combination has to involve a different (new) point of view of the investigated effects, it has “to filter out” only feasible results and methods. It can be stated, that the creators of this discipline ‘hit the bull’s eye’, since the informatics revolution provided the excellent tool, such as the developed signal analysis. Thereby the vibroacoustics can be classified as the interdisciplinary science operating in the common space of the theory of vibration, acoustics and measurements of dynamic effects.

However, the question arises: Is the defining of this common space identifiable as “own axiom and language”? Let us look at the following problem. The theory of vibration and acoustics has provided mathematical models. The signal analysis has introduced the interpretation of the reality observation. Vibroacoustics has to combine such results reasonably. It must have – at its disposal – the language allowing for the common interpretation of the model calculations results and the measurement results. Therefore the efforts can be undertaken to define the bases of the subject originating either from the relation: the observed signal  $\Leftrightarrow$  mathematical model or from the Reciprocity Principle.

Does it mean that the vibroacoustics has its own axiom and language? The author’s deliberations concerning this problem are presented in the lecture.

★ ★ ★

## 11. Sound-absorbing and insulating enclosures for ultrasonic range

DOBRUCKI Andrzej, andrzej.dobrucki@pwr.wroc.pl

ŻÓŁTOGÓRSKI Bronisław, bronislaw.zoltogorski@pwr.wroc.pl

PRUCHNICKI Piotr, piotr.pruchnicki@pwr.wroc.pl

BOLEJKO Romuald, romuald.bolejko@pwr.wroc.pl

Wrocław University of Technology

Institute of Telecommunications, Teleinformatics and Acoustics

Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

The sound-absorbing and insulating enclosures are usually applied for the reduction of noise radiated by working machines in the industrial halls. The sound insulation is provided either by the solid or layered walls. The sound absorbing inside the enclosure is obtained by application of the sound absorbing material, e.g. mineral or glass wool for covering of the walls. Some machines, e.g. welders, produce the noise in ultrasonic range 20–30 kHz. In this frequency range, the physical phenomena appear which should

be taken into account in the process of design of the enclosure. These phenomena are: sound absorption in the air, coincidence between the acoustic waves in the air and bending waves in the walls. Also the properties of sound-absorbing materials are not known for ultrasonic frequencies. These problems are subjects of the presented paper. The investigation shows that the absorption in air is not an influent factor for small-size enclosures. However, the coincidence causes significant decrease of the sound insulation of the walls. As the optimal sound-absorbing material, the boards made of ceramic fibers have been chosen. They are dense but deeply porous structures. The enclosure for reduction of 20-kHz noise produced by a welding machine has been manufactured and reduction of 20 dB of peak and  $L_{eq}$  levels have been achieved.

★ ★ ★

## 12. The influence of selected risk factors on the hearing threshold level of noise exposed employees

DUDAREWICZ Adam<sup>1</sup>, adudar@wp.pl

TOPPILA Esko<sup>2</sup>

PAWLACZYK-ŁUSZCZYŃSKA Małgorzata<sup>1</sup>

ŚLIWIŃSKA-KOWALSKA Mariola<sup>1</sup>

<sup>1</sup> Nofer Institute of Occupational Medicine

Department of Physical Hazards

Św. Teresy 8, 91-348 Łódź, Poland

<sup>2</sup> Institute of Occupational Health

Department of Physics

Topeliuksenkatu 41 a A FI-00250, Helsinki, Finland

The aim of the study was to evaluate the combined effect of noise exposure and additional risk factors on permanent hearing threshold shift. Three additional risk factors were considered: exposure to organic solvents, smoking and elevated blood pressure.

The data on exposure and health status of employees were collected in 24 factories. The study group comprised 3741 male noise-exposed workers of: mean age  $39 \pm 8$  years, mean tenure  $16 \pm 7$  years and  $L_{EX,sh} = 85.6 \pm 5.1$  dBA. For each subject, pure tone audiometry examination was performed, blood pressure and noise exposure were assessed using collected data of measurement and examinations performed during occupational activity, whereas smoking and solvent exposure were assessed with questionnaire. The study group was divided into subgroups with respect to the considered risk factors.

In the analysis, the distribution of hearing level of each subgroup was compared to the predicted one, with standard calculation method described in ISO 1999:1990. For each of the considered risk factors, the difference between the measured and calculated hearing level distribution was used to establish, by the least square method, the noise dose related correction square function for the standard method.

The considered risk factors (solvent exposure, smoking and elevated blood pressure) combined with noise exposure may increase the degree of hearing loss. The influence of solvent exposure and smoking on hearing loss are noise dose-dependent while in the case of elevated blood pressure, the influence is independent of the noise dose.

★ ★ ★

### 13. Vibration in coal mines: harmful sources, influence on human organism and prophylaxis of vibration disease among miners

DUDNYK Igor M., igdudnyk@yahoo.com

KOSSENKOVA–DUDNYK Olena A.

Donetsk National Medical University, DNMU

16 Illich av.83003 Donetsk, Ukraine

The aim of this study is estimation of vibration on workplaces among main professional groups of miners (face-workers, drifters, engine-drivers of compressed air and electric locomotives) and prevention of vibration disease (VD) in coal mines of Donetsk coal basin (Donbas). Vibration in coal mine is one of the present production factors at workplaces of miners. It is the cause of origin of VD. For prognosis of risk of professional pathology among miners, we should know the intensity of hand-arm and whole-body vibration, dominant frequency, duration of influence in a day or shift, duration of production experience. Moving of transport and transport-technological means on a railway is accompanied by mechanical fluctuations. They are transferred engine-drivers through a floor in position costing and through a chair (in sitting position). Such mechanical fluctuations are changeable vacillating. The dozes estimation of vibration on the studied workplaces of coal mines in Donbas testifies that this harmful production factor, which demands a regulation of its influence and necessity of use of protection measures. It is a necessary action for restriction of its adverse influence, with the purpose of risk depression among underground miners. Prevention system for this disease is complex of organizing technical, technological and hygienic regulations, standards (primary prophylaxis) and medical-prophylactic measures (secondary prophylaxis).

\* \* \*

### 14. From the history of the Noise Control Conference

ENGEL Zbigniew Witold, engel@agh.edu.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

AGH University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

In the article a short historical outline of noise control conferences organized in Poland is given. Those conferences with the participation of Polish specialists have been organized since 1964; since 1976 they have been evolved into International Noise Control Conferences. Silhouettes of four Polish scientists, which have made a large contribution to the noise and vibration control in Poland, are presented. Also the current state of threats by noise and vibrations have been briefly mentioned. The significance of such conferences has been emphasized.

\* \* \*

### **15. The reduction of vibrations of pedestrian bridges with using of tuned mass dampers (TMD)**

FIEBIG Wiesław, wieslaw.fiebig@pwr.wroc.pl

Wrocław University of Technology

Institute of Machine Design

Łukasiewicza 7/9, 51-377 Wrocław, Poland

The reduction of structural vibrations on the example of two pedestrian bridges (in Poznań and Wrocław) with using of tuned mass dampers has been presented in the paper. The results of theoretical and experimental studies of pedestrian bridges vibrations have been described and discussed. The natural frequencies of the bridges have been calculated using FEM (Final Element Method) and measured with EMA (Experimental Modal Analysis). Based on the results of the calculations and measurements, the tuned mass dampers (TMD) were designed and mounted to the structure of the bridges. The measurements after the assembly of TMD show high efficiency of the dampers at the first natural frequencies at 1 Hz (bridge in Poznań) and at 1.4 Hz and 1.6 Hz (bridge in Wrocław).

★ ★ ★

### **16. Noise reduction using an active structure of variable sound insulation**

GÓRSKI Paweł<sup>1</sup>, pawel@ciop.pl

KOZUPA Michał<sup>2</sup>

<sup>1</sup> Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

<sup>2</sup> AGH University of Science and Technology  
Al. Mickiewicza 30, 30-059 Kraków, Poland

Additional sound sources are used as actuators in the vast majority of active sound reduction systems. One of the possible opportunities to extend the field of applications of active noise reduction systems is using active structures of variable sound insulation. The paper presents an analysis of the possibility for noise reduction using a structure of variable sound insulation consisting of a metal plate, active elements (MFC), and a control system. The paper presents results of acoustic radiation simulations and measurements of sound intensity generated by the structure under the influence of stimulation by acoustic wave. Simulations of mechanical vibrations and acoustic radiation for the plate have been performed using the finite element method and the ANSYS software program. Simulation results allowed the selection of locations for gluing the active elements and sensors. Analyses of the sound pressure level in the space to which the plate is radiating allowed the determination of dominant frequencies in the characteristics, and in effect the indication of vibration modes that can be subject to reduction. Sound intensity measurements have been performed using a three-way probe of USP mini Miroflown. Results of simulations and measurements show that it is possible to achieve an improvement of the insulating power of a metal plate by approx. 10 dB.

★ ★ ★

## 17. Estimation of accident rates for workers exposed to the various noise levels in the car assembly factory

JANKOWSKA D.<sup>1,2</sup>

GRAS S.<sup>1</sup>

<sup>1</sup> Firm LABOD

Św. Rocha 2c/8, 61-142 Poznań, Poland

<sup>2</sup> Poznań University of Technology

Faculty of Computing Science and Management

Strzelecka 11, 60-965 Poznań, Poland

Industrial noise is one of the undesired physical contaminants which can significantly affect safety of workers. Many workplaces such as car assembly factories are associated with high acoustic noise levels. Due to the particular activity performed in such factories, any reduction of the noise is a difficult task. Moreover, exposure of workers to the high level of noise can increase the number of accidents. Therefore, it becomes essential to estimate an accident risk in relation to the noise to which the workers are exposed.

In this work, we present the evidence of a strong correlation between the accident rate and various noise levels. Study was carried on a group of 871 male workers from the production line in the welding hall of the car assembly factory. This group constitutes a statistical sample, ideal for this analysis, i.e. equal age of all workers, similar work experience, and comparable workload. All workers were exposed to various noise levels in the range of 60–96 dBA, depending on their work location. This analysis based on the accidents records from 3 successive years, up to 2009.

It has been revealed that the accident rate rises exponentially as the noise level increases. For workers exposed to the noise above 90 dBA, the accident chance can be as high as 5.5% per year. However, when the noise level is about 70 dBA, the accident chance is reduced by a factor of  $\sim 6$  with respect to 90 dBA case. These results can be considered as a general picture in any industrial workplace characterized by a similar noise exposure.

\* \* \*

## 18. Recognition of selected noise sources in a long-term environmental monitoring

KŁACZYŃSKI Maciej, mklaczyn@agh.edu.pl

AGH University of Science and Technology

Department of Mechanics and Vibroacoustics

Al. Mickiewicza 30, 30-059 Kraków, Poland

In Poland the development of the domestic communication has become one of the main sources of noise hazards in the environment over the last 20 years. The road noise has been the acoustic climate dominant factor, due to its widespread nature and prolonged effect. However, the importance of noise generated by flights, takeoffs and landing of aircrafts. Since the Poland's accession to the European Union and the Polish sky becoming fully accessible for aircraft carriers, the air traffic has been growing rapidly. The growth of the air traffic in the coming years is predicted to be lower than the current one, according to the forecast of the Civil Aviation Office, however it will be still higher

than the European average. Introduction of a long-term research in areas where the human domicile is exposed to a risk of noise, has currently been an important issue. Such studies are designed to collect data on the prevailing climate of acoustic and deriving conclusions, reports and maps of the areas most exposed to the risk of noise limits being exceeded. Continuous monitoring of a particular area raises problems of large quantities of the recorded data, which often represent information unrelated to the study source. Manual verification of data is time-consuming and costly. Therefore, to develop effective methods for automatic identification of transport noise sources becomes an important task for proper determination of the noise levels. This paper presents a method of automatic classification of transport noise sources in the acoustic environmental monitoring.

\* \* \*

### **19. Urbanised area management system from the perspective of the acoustic effect**

KOMPAŁA Janusz, j.kompala@gig.eu

Central Minning Institute

Pl. Gwarków 1, 40-166 Katowice, Poland

All over the urbanised areas, there are many large parts of land that emit noise to the environment. They may be surrounded by the areas that are under the acoustic protection. Such situation results in many complications. Some of them are associated with inability to keep the requirements connected with acoustic protection. That is why the urbanised areas should be properly managed, taking into consideration controlling of the investment policy as well as actions taken in order to maintain or restore acoustic characteristic of the used or even degraded areas (revitalisation). It should be mentioned that such procedures cannot be treated as a temporary solution but should have an organised structure which is distinguished by the particular relations between all the parts of it, as well as by the characteristic of this relations. In case of the acoustic management, the system is composed of such activities as: setting objectives and realisation of them in the particular area. Providing tools to improve the management and decision making on the investment in order to optimise and preserve the socio-economic importance of areas, should be the imperative.

\* \* \*

### **20. Long-term comparative evaluation of acoustic climate in selected schools before and after acoustic adaptation**

KOTUS Józef, joseph@sound.eti.pg.gda.pl

SZCZODRAK Maciej

CZYŻEWSKI Andrzej

KOSTEK Bożena

Gdańsk University of Technology

Multimedia Systems Department

Narutowicza 11/12, 80-233 Gdańsk, Poland

The results of long-term continuous noise measurements in two schools are presented in the paper. Noise characteristics are measured continuously at selected locations for approximately 16 months. Measurements started eight months prior to the acoustic

treatment of the corridors. A comparative evaluation of the acoustic climates in selected schools before and after the acoustic treatment was performed based on these two periods of continuous measurements. The autonomous noise monitoring stations, engineered at the Multimedia Systems Department of the Gdańsk University of Technology are used for this purpose. Investigations of measured noise, particularly its influence on hearing, based on a spectrum analysis in critical bands are discussed. Effects of occupational noise exposure, including the Temporary Threshold Shift simulation, are determined. The results of the above discussed measurements correlated with the instantaneous noise levels are also presented.

\* \* \*

## **21. Examining the effectiveness of anti-vibration gloves using neural network**

KOWALSKI Piotr, pikow@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

The effectiveness of protection against vibration of anti-vibration gloves not only depends on the materials used in their manufacture, but also the parameters associated with the source of vibration. Depending on the parameters characterizing the vibration, the same measure of protection may have radically different effectiveness values. This article presents a methodology of testing anti-vibration gloves using a neural network, which has the task of mapping of gloves in various conditions (i.e. the vibration of various amplitudes and spectra, and the various forces exerted by the worker on a tool) learning neural network implemented on the basis of real measured vibration signals produced by different tools. Shown evidence of good results reflect the real gloves by their models have resulted from the train neural network.

\* \* \*

## **22. Whole-body and hand-arm vibration in works transport**

KOWALSKI Piotr, pikow@ciop.pl

ZAJĄC Jacek, jazaj@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

A dynamic economy contributes to the increase in the number of workers exposed to mechanical vibration that occur during work with machines and transport equipment. Due to its nature, means of transport are an insufficiently recognized group of sources of mechanical vibrations. The article presents the results of whole-body and hand-arm vibration tests of 30 selected transport means. Studied objects represented by vehicles and equipment are mostly used in works transport. On the basis on an analysis of the vibration signals recorded on each workplace in accordance with PN-EN 14253 and PN-EN ISO 5349, it was determined that

- Weighted values of components of directional vibration acceleration,
- The values of vibration daily exposure  $A(8)$ .

To assess whole-body and hand-arm vibration exposure on the tested work places of works transport, indices of limit value exceed, the total evaluation index (developed in previous work CIOP-PIB), and three-degrees scale assessment of exposure to vibrations

were used. The assessment showed that analyzed work places may cause a major hazard. Vibration hazards at all tested work places were classified on the second or third degree of scale.

\* \* \*

### **23. Effect of musician's earplugs on sound level and spectrum during musical performances**

KOZŁOWSKI Emil, emkoz@ciop.pl

ŻERA Jan

MŁYŃSKI Rafał

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

In this study, change in *A*-weighted and 1/3 octave sound pressure levels (SPLs) was used to assess the influence of wearing earplugs by musicians on their musical performances. Seven soloists and three musical assemblies performed four pieces of music with musician's earplugs donned and doffed. They used the silicon custom moulded earplugs with acoustic filters designed to attenuate sound by 9, 15 or 25 dB. Results showed that the use of earplugs affected sound level and spectrum of played sounds. This effect was the largest for brass players. The difference between SPLs in high-frequency 1/3-octave bands and *A*-weighted SPLs without and with earplugs, respectively exceeded 15 and 5 dB. Moreover, change in level and spectrum of played sounds, enlarged with increasing earplugs' sound attenuation values. Similar changes for woodwind, percussion and string instruments were less noticeable than those for brass instruments equaling no more than 5 dB for 1/3 octave spectra and no more than 2 dB for *A*-weighted SPL.

\* \* \*

### **24. Active noise control algorithm based on a neural network and nonlinear input – output identification model**

KRUKOWICZ Tomasz, tokru@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

The development of digital signal processors and the increase in their computing capabilities bring opportunities to employ algorithms with multiple variable parameters in active noise control systems. Of particular interest are the algorithms based on artificial neural networks. This paper presents an active noise control algorithm based on a neural network and a nonlinear input-output system identification model. The purpose of the algorithm is an active noise control system with a nonlinear primary path. The algorithm uses the NARMAX system identification model. The neural network employed in the proposed algorithm is a multilayer perceptron. The error backpropagation rule with adaptive learning rate is employed to update the weight of the neural network. The performance of the proposed algorithm has been tested by numerical simulations. Results for narrow-band input signals and nonlinear primary path are presented below.

\* \* \*

## 25. Adaptive algorithms for enhancement of speech subject to a high-level noise

LATOS Mariusz, Mariusz.Latos@polsl.pl  
PAWEŁCZYK Marek

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

There are many industrial environments which are exposed to a high-level noise, sometimes much higher than the level of speech. Verbal communication is then practically unfeasible. In order to increase the speech intelligibility, appropriate speech enhancement algorithms can be used. It is impossible to filter off the noise completely from the acquired signal by using a conventional filter, because of two reasons. First, the speech and the noise frequency contents are overlapping. Second, the noise properties are subject to change. The adaptive realisation of the Wiener-based approach can be, however, applied. Two structures are possible. One is the line enhancer, where the predictive realisation of the Wiener approach is used. The benefit of using this structure is that it does not require additional apparatus. The second structure takes advantage of the high level of noise. Under such condition, placing another microphone, even close to the primary one, can provide a reference signal well correlated with the noise disturbing the speech and lacking the information about the speech. Then, the classical Wiener filter can be used, to produce an estimate of the noise based on the reference signal. That noise estimate can be then subtracted from the disturbed speech. Both algorithms are verified, based on the data obtained from the real industrial environment. For laboratory experiments the G.R.A.S. artificial head and two microphones, one at back side of an earplug and another at the mouth are used.

\* \* \*

## 26. Noise Dose Index based on hearing deterioration equivalencies adapted from ISO 1999

LIEDTKE Martin, martin.liedtke@dguv.de

Institute for Occupational Safety and Health  
German Social Accident Insurance – IFA  
Alte Heerstrasse 111, D-53757 Sankt Augustin, Germany

For the work-related occurrence of occupational hearing impairment, publications often specify imprecisely only “long lasting” and “perennial”, as the required exposure duration relating to a daily noise exposure level of 90 dB(A), respectively 85 dB(A). Within occupational medical care, these specifications are not adequate to enable the estimation of noise-induced aggravation, in addition to an already existing hearing deterioration. Therefore within occupational medical care and within the framework of the appraisal of occupational hearing impairment, a Noise Dose Index is required, which determines the occupational noise dose according to acknowledged scientific findings using the details presented in the exposure periods or expected coming periods.

Noise-induced equivalent hearing threshold shift curves are calculated based on ISO 1999:1990. A Noise Dose Index is developed for the report of the occupational noise dose,

which allows to consider hearing-threshold-shift equivalently to the noise exposures of all periods. It is demonstrated that the equivalent hearing threshold shift curves are independent of sex, of age and of fractile for fractiles  $Q < 0.50$ . The Noise Dose Index is calculated using mathematical formula and algorithms deduced from ISO 1999.

Basing on the procedure presented here and adapted from ISO 1999, a Noise Dose Index is deduced for that half of the population, which shows the most sensible hearing in respect of hearing deterioration or hearing impairment. This Noise Dose Index is valid for each single individual and his working life exposure.

\* \* \*

## **27. Action plans to limit the impact of noise in large agglomerations – conditions and problems**

LIPOWCZAN Adam, a.lipowczan@gig.eu

Central Mining Institute

Plac Gwarków 1, 40-166 Katowice, Poland

The EU Directive 2002/49/EC had introduced, in the member countries, the obligation of preparing acoustic maps of cities within the defined time limits, and preparing them on the basis of plans of noise reduction by 18th July, 2008. In Poland, these actions are considerably delayed while, at the same time, the methodological and organisational ambiguities give rise not only to unfulfilling the time limits specified in the directive, but, which is more important, threaten with introducing in the plans the actions and investments of low or limited efficiency, but having important economic consequences.

\* \* \*

## **28. Safety of workers exposed to noise – the evaluation of National Labour Inspectorate**

LIWO Marian

National Labour Inspectorate

Krucza 38/42, 00-926 Warszawa, Poland

The scope of activities and powers of National Labour Inspectorate are defined by the Act of 13 April 2007 on National Labour Inspectorate. One of its tasks is to prevent and eliminate hazards in the working environment in Polish companies.

In the years 2007–2008 labour inspectors controlled, with the use of unified methodology, 1227 companies in which the noise occurred. More than 80.000 persons (43% of the employees in total) were exposed to noise, including 35% exposed to noise exceeding maximum admissible intensity level (MAI). Small and medium-sized enterprises – manufacturers of cement, concrete and plaster products, textiles, oils and vegetable fat, semitrailers, cars as well as printing companies accounted for 49% of the controlled companies. The objective of the inspection was to determine which activities, if any, were taken by employers to reduce or eliminate the noise, according to the regulation of Minister of Economy and Labour of 5 August 2005 on work safety and health during work involving exposure to noise or mechanical vibrations as well as to define which types of activities were taken and what were their effects.

The comparison from the years 2007 and 2008 shows that most of the irregularities discovered during the inspections were related to corrective activities in the area of technical and organizational solutions (their lack, as a matter of fact), consideration of relevant information in the risk assessment (e.g. time and level of exposure, overtime work) as well as training of workers, including the information resulting from occupational risk assessment.

The inspections have also shown that it was not always possible to access the required measurement data at a later date. In every fourth company where the noise intensity measurements were carried out, the required documentation from the measurements was not kept at all or was not kept according to the regulations.

Both in 2007 and 2008 the employees (16%) worked overtime at workstations where MAI levels were exceeded.

The inspectors have also had reservations to the preventive medical examinations of workers exposed to noise, since the doctors were not always informed by the employers about the occurrence of noise at workstation and its level.

★ ★ ★

### **29. Active structural acoustic control using the Filtered-Reference LMS algorithm with compensation of vibrating plate temperature variation**

MAZUR Krzysztof, [krzysztof.mazur@polsl.pl](mailto:krzysztof.mazur@polsl.pl)  
PAWELCZYK Marek, [marek.pawelczyk@polsl.pl](mailto:marek.pawelczyk@polsl.pl)

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

Vibrating plates have been recently used for a number of active noise control applications. They are resistant to difficult environmental conditions including dust, humidity, and even precipitation. However, their properties significantly depend on temperature. The plate temperature changes, caused by ambient temperature changes or plate heating due internal friction, result in varying response of the plate, and may make it significantly different from the response of a fixed model. Such mismatch may deteriorate performance of an active noise control system or even lead to divergence of a model-based adaptation algorithm. In this paper, effects of vibrating plate temperature variation on a feedforward adaptive active noise reduction system with the multichannel Filtered-Reference LMS algorithm are examined. For that purpose, a thin aluminum plate is excited by multiple Macro-Fiber Composite actuators. The plate temperature is forced by a set of Peltier devices, what allows for both cooling and heating of the plate. The noise is generated at one side of the plate, and a major part of it is transmitted through the plate. The goal of the control system is to reduce sound pressure level at a specified area on the other side of the plate. To prevent successful operation of the control system due to plate temperature variation, a gain-scheduling scheme is proposed to support the Filtered-Reference LMS algorithm.

★ ★ ★

### **30. Adaptive active noise control of sound transmitted through a plate with insufficient acoustic isolation**

MAZUR Krzysztof, krzysztof.mazur@polsl.pl  
PAWELCZYK Marek, marek.pawelczyk@polsl.pl

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

Reducing acoustic pressure level of sound transmitted through a plate is of great scientific interest because of a number of potential applications. It is known that simply reduction of vibration of the plate is not an efficient way for that purpose, particularly if the sound also leaks by some other paths due to insufficient insulation. Sound pressures at different points in space are rather measured and reduced then. They are considered as error signals used for updating parameters of adaptive filters. This paper presents an adaptive multichannel Filtered-Reference LMS-based algorithm for active control of noise transmitted through a clamped rectangular thin aluminum plate with insufficient acoustic insulation. The proposed cost function to be minimized combines sound pressures at a reduced number of specified points and plate vibration measurements. The plate is excited with multiple Macro-Fiber Composite actuators.

\* \* \*

### **31. Human Vibration measurement and evaluation: an updating**

MICCOLI Giuseppe, g.miccoli@imamoter.cnr.it

Institute for Agricultural and Earthmoving Machines, IMAMOTER  
National Research Council, C.N.R.  
Via Canal Bianco, 28 – 44124 Cassana (Ferrara), Italy

The Vibration Directive 2002/44/EC seeks to introduce, at the Community level, minimum protection requirements for workers when they are exposed to risks arising from vibration.

The Vibration Directive has been implemented in several European countries since July 2005. It results in many questions from employers, hygienists and exposed persons on how to evaluate vibration, what are the situations at risks, what are the effects of vibration, how to reduce vibration, how to develop an action plan for prevention.

Nowadays, in particular in the hand-held machine/tool field, many European Technical Committees expressed the need of measuring the pressure and pushing force applied by the operator to the machine/tool handling during test, carried out in working conditions. That is done mainly in order to qualify these products by improving test result repeatability and vibration measurement reproducibility and by assessing their compliance to Safety of Machinery Directive 2006/42/EC.

The author of this paper has been in charge as coordinator and partner of the EU DOPTEST Project, IV FP, and its exploitation, i.e. the EU VIBTOOL Project, V FP, dealing with the application of innovative techniques based on laser vibrometry and sensor matrixes, aimed at hand-arm vibration measurement and hand-held vibrating tools grip force mapping.

The objective of this contribution consists in providing an overview and updating on human vibration hazard prevention, legislation, Vibration Directive practical application and practices, with particular emphasis on the hand-arm vibration field.

\* \* \*

### **32. Determining the level of sound power of noise sources using the traversing method for measuring the level of sound pressure**

MIKULSKI Witold, wimik@ciop.pl

RADOSZ Jan

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

The sound power level is the basic parameter for determining noise emission of sound sources. It is determined from the energy average of time-averaged sound pressure levels at all measurement points on the measurement surface. The number of measurement points has to reflect the directivity of noise emission. Ultrasonic noise sources require many more measurement points because the acoustic energy they emit is more directional than that of noise sources in the audible frequency range. For sources of industrial ultrasonic noise there are often more than 1000 points. This article presents a less time-consuming solution of determining the averaged sound pressure level on the measurement surface: traversing (a traversing microphone at a constant velocity along measurement paths). The use of this method for sources of ultrasonic noise is similar to its use in the pressure method (in the frequency range from 50 to 1000 Hz) and the intensity method (in the frequency range from 50 to 6300 Hz). However, it considers the specifics of the frequency range from 10000 to 40000 Hz. The method presented in this article covers traversing on the measurement surface with fixed measurement points and a noise source mounted on a turntable.

\* \* \*

### **33. Assessment of measurements and simulation results in sound field in rooms with changes in location of sound source and the receiver**

MLECZKO Dominik

WIERZBICKI Jacek, wierzbic@agh.edu.pl

AGH – University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

The guidelines for testing the parameters of acoustic space has no standards for measuring the location of the track elements, such as a sound source and receiver. Measurements are based on the experience of the person conducting the measurements. The paper presents the results of computer simulations and measurements in real conditions, changing the location of source and microphone. The object of measurement was to determine the sound pressure levels and other parameters of the designated room impulse response.

\* \* \*

### **34. The use of genetic algorithms for limitation of occupational exposure to noise – simulation research**

MORZYŃSKI Leszek, lmorzyns@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

In this paper the possibility of the use of genetic algorithms for limitation of occupational exposure to noise has been presented. As an example the noise source placement in the workroom have been discussed. The method of coding parameterized noise source placement process in the genetic algorithm and conditions in need of fulfillment by the code sequence have been described. The fitness function for evaluation of individuals during the process of optimization of noise sources location have been defined. Simulation results and its conclusions have been presented.

★ ★ ★

### **35. Earplug actuator selection for a miniature personal active hearing protection system**

PAWEŁCZYK Marek, Marek.Pawelczyk@polsl.pl

LATOS Mariusz

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

There are many industrial environments which are exposed to a high-level noise. It is necessary to protect people from the noise. Most of the time, the consumer requires a miniature version of a noise canceller to satisfy the internal working place requirements. Very important thing is to select the most appropriate personal hearing protection device, for example an earplug. It should guarantee high passive noise attenuation and allow for secondary sound generation in case of active control. In many cases the noise is nonstationary. For instance, some of the noisy devices are switched on and off, speed of some rotors or fans changes, etc. To avoid any severe transient acoustic effects due to potential convergence problems of adaptive systems, a fixed-parameter approach to control is appreciated. If the noise were stationary, it would be possible to design an optimal control filter minimising variance of the signal being the effect of the acoustic noise and the secondary sound interference. Because of noise nonstationarity for most applications, the idea of generalised disturbance defined by a frequency window of different types has been developed by the authors and announced in previous publications. The aim of this paper is to apply such an approach to different earplugs and verify its noise reduction properties. Simulation experiments are conducted based on real world measurements performed using the G.R.A.S. artificial head equipped with an artificial mechanical ear, and the noise recorded in a power plant.

★ ★ ★

### 36. Evaluation of sound exposure and risk of hearing impairment in orchestra musicians

PAWLACZYK-ŁUSZCZYŃSKA Małgorzata, mpawlusz@imp.lodz.pl  
DUDAREWICZ Adam, ZAMOJSKA Małgorzata  
ŚLIWIŃSKA-KOWALSKA Mariola

The Nofer Institute of Occupational Medicine  
Department of Physical Hazards  
Św. Teresy 8, 91-348 Łódź, Poland

The aim of the study was to assess the sound exposure and the risk of noise-induced hearing loss (NIHL) in classical orchestral musicians. The subjects of the study comprised 129 musicians from two symphony, brass and opera orchestras. They were asked to complete a questionnaire aimed at identification of the occupational and non-occupational risk factors of the NIHL. The questionnaire inquiries were supplemented by measurements of sound pressure levels during rehearsals and concerts, or performances with the measuring equipments placed in various instrument groups. Based on these data, the risk assessment of the NIHL was performed according to ISO 1999:1990. The classical orchestral musicians are usually exposed to sound at equivalent continuous *A*-weighted sound pressure levels of 79–91 dB (10th–90th percentile) for 20–45 hours per week (10th–90th percentile). Occupational exposures to such sound levels over 40 years of employment cause the risk of hearing impairment (expressed as mean hearing threshold level for 2, 3 and 4 kHz exceeding 25 dB) in the range of 13–33% and 9–33% in case of females and males, respectively. The highest risk is related to playing a clarinet, tube, trumpet, trombone, horn and percussion section.

\* \* \*

### 37. Hearing ability in orchestral musicians

PAWLACZYK-ŁUSZCZYŃSKA Małgorzata, mpawlusz@imp.lodz.pl  
DUDAREWICZ Adam, ZAMOJSKA Małgorzata  
ŚLIWIŃSKA-KOWALSKA Mariola

The Nofer Institute of Occupational Medicine  
Department of Physical Hazards  
Św. Teresy 8, 91-348 Łódź, Poland

Pure-tone audiometry was performed on 63 classical orchestral musicians in connection with a questionnaire inquiry, aimed at the identification of occupational and non-occupational risk factors of the noise-induced hearing loss and the self-assessment of hearing statement. Additionally, subjects' hearing ability was assessed using the Amsterdam Inventory for Auditory Disability and Handicap (AIADH). The questionnaire inquiries were supplemented by measurements of sound pressure levels during rehearsals and during concerts in the two symphony and one opera orchestras, with the measurement equipments placed in various instrument groups.

The musicians' actual hearing threshold levels were compared with the theoretical predictions calculated according to ISO 1990:1990, based on sound exposure data for various instrument groups. The audiograms were also related to the results of hearing ability assessment expressed in terms of scores in the AIADH.

\* \* \*

### **38. Surface acoustic impedance estimation using inverse method**

PIECHOWICZ Janusz, piechowi@uci.agh.edu.pl

AGH – University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

Sound field parameters prediction using numerical methods is applied in sound control systems, in acoustical building projects and sound field simulations. Those methods need to define the acoustic properties of surfaces such as the sound absorption coefficients or the acoustic impedance to determine boundary conditions. The values of those properties measured in laboratories can be found in tables or data bases, but often they are different from the properties material *in situ*. Several *in situ* techniques were developed. One of the techniques was based on the use of two microphones to measure the direct and reflected sound over the planar test surface and the reflection coefficient is calculated from the amplitude and phase relationships between the direct sound and the reflected sound. Another approach is applied in the inverse boundary elements method. The estimation of the acoustic impedance of the surface is formulated as an inverse boundary problem. The boundary values can be found from the multi point sound pressure measurements in the interior of the room. This method is applicable to arbitrary-shape surfaces. The presented investigation is a part of the research program on the application of inverse methods on industrial room acoustics.

★ ★ ★

### **39. Methodology of testing of acoustic field distribution in power plants of complex structure**

PIERCHAŁA Marek, mpierchala@komag.eu

Institute of Mining Technology KOMAG  
Pszczyńska 37, 44-101 Gliwice, Poland

Conventional power plants and small cogeneration plants are the most significant sources of industrial noise emission. It often happens that their operation causes noise emission to the environment at the level exceeding permissible values. Also noise emission levels are found to be excessive inside buildings of power plants at workplaces.

Power plants, due to their specific features that result from their significance for the national economy, are very difficult to be tested as regards acoustic analyses using the classic methodology. For that reason, a special methodology addressed to testing power plants based on measurements that use intensive sound method as well as on modelling acoustic field distribution in closed rooms and in environment, has been developed. The paper presents verification of the methodology, developed by the author, with special attention paid to tests for different load of turbogenerators. Tables of difference of sound levels in calibration points of the model as well as differential maps enabled to conclude that the method developed by the author is more suitable for carrying out tests aiming at determination of measures to reduce noise emission than other methods being used.

★ ★ ★

#### **40. Method of acoustic assessment of machinery based on global acoustic quality index**

PLEBAN Dariusz, daple@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

For the use of acoustic assessment of machinery, a global index of acoustic quality has been developed. Acoustic quality index is considered as a product of the following partial indices: sound power index, index of distance between the workstation and the machine, radiation directivity index, impulse and impact noise index and noise spectrum index. Each partial index always assumes positive value. If the value of global index does not exceed 1, the noise of the assessed machine will not exceed the admissible value of *A*-weighted sound pressure level at the workstation.

Experimental tests were carried out in order to determine the values of global indices for a group of engine-generators, with the use of inversion method allowing for the determination of sound power level. The correctness of the determined values of indices was confirmed by the results of *A*-weighted sound pressure level measurements, at the hypothetically assumed workstations in simulated *in situ* conditions.

\* \* \*

#### **41. Monitoring the reaction and response of people to urban noise**

POPESCU Diana Ioana, Diana.Popescu@mep.utcluj.ro  
MOHOLEA Iuliana Fabiola

Technical University of Cluj-Napoca  
Faculty of Machine Building  
B-dul Muncii 103-105, 400641 Cluj-Napoca, Romania

An important aspect in assessing noise in urban agglomerations is the subjective one, which takes into account the sensitivity and specific reactions of residents to the noise in their living environment. This paper presents results of a sociological study initiated to determine the population awareness, regarding the urban acoustic environment and estimation of effects and disturbance. The survey was conducted in a Romanian city, to complement the information provided by the strategic noise map of the area. This approach allows the estimation of specific local patterns of reaction and response to urban noise of the exposed population and provides the information, needed to develop action plans and to set proper solutions for urban area planning.

\* \* \*

#### **42. Analysis of acoustic environment on premises of nursery schools in Wrocław**

RUDNO–RUDZIŃSKA Barbara, barbara.rudno-rudzinska@pwr.wroc.pl  
CZAJKOWSKA Karolina

Wrocław University of Technology  
Institute of Telecommunications, Teleinformatics and Acoustics  
Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

Being connected with the temporary stay of children, the premises of nursery schools are legally subject to noise protection. By comparing the measured noise level indices

$L_{AeqD}$  with the permissible value, one can find out if the noise protection requirements are satisfied or not. But this is not sufficient to assess the quality of the acoustic environment in a given area.

The aim of this project was to create a ranking of the nursery schools in Wrocław with regard to the quality of the acoustic environment on their premises, using a specially developed evaluation methodology. Each nursery school was rated according to an adopted grading scale on the basis of the noise level distribution on the playground and on the nursery school building elevation. Using the grading scale one can classify the nursery school premises into twelve categories characterized by different acoustic environment quality, from exceptionally good (< 45 dB) to exceptionally bad (> 70 dB).

Only the road noise, which is the dominant source of noise in large urban agglomerations, was taken into account in the investigations. The available (appropriately rescaled) data from the acoustic map of Wrocław and the authors' own measurements and simulation analyses were used. The developed methodology was verified by comparing the ratings yielded by it with those determined on the basis of field measurements and simulation studies, carried out for several selected nursery schools.

The paper presents the results of an acoustic environment quality assessment carried out, using the developed investigative methodology, for 118 nursery schools located in Wrocław.

\* \* \*

#### **43. Remarks on the assessment of ultrasonic noise impact on human body**

ŚLIWINSKI Antoni, [fizas@univ.gda.pl](mailto:fizas@univ.gda.pl)

University of Gdańsk

Institute of Experimental Physics

Wita Stwosza 57, 80-952 Gdańsk, Poland

The impact of ultrasonic noise on human body related to its hazard assessment at work places, present a permanent interesting problem and it is still far from a satisfactory solution. Many attempts undertaken in different countries (also in the Central Institute of Labour Protection – National Research Institute, Poland) to elaborate reliable procedures for the assessment of ultrasonic noise hazard, have shown various aspects of the problem important for practical use. There are some physical aspects which should be (and in many cases are) taken into account in research, however not always properly argued and explained. In the presentation, a review of these aspects will be given and considered in relation to ultrasonic noise generation and propagation including its spectrum, attenuation, diffraction and directivity properties.

\* \* \*

#### **44. Noise at workplaces in call center**

SMAGOWSKA Bożena, [bosma@ciop.pl](mailto:bosma@ciop.pl)

Central Institute for Labour Protection – National Research Institute

Czerniakowska 16, 00-701 Warszawa, Poland

In the last years the number of new forms of workplaces, such as call centers, increases. It is defined as a workstation where the basic tasks of a worker are carried out with the use of a phone and a computer. According to statistics, about 1.3–4% of workers are employed in call centers in the European countries. The noise is one of the harmful

and bothersome hazards of call center workstations. The paper presents the noise sources in call center rooms, assessment criteria of noise and results of noise measurements in call center workstations. The results of measurements show that the noise at call center workstations (during the use of handset receiver phone by operators) can be harmful (causing the risk of hearing loss) and bothersome, as it makes it difficult to carry out the basic work activities and causes extra auditory disadvantageous changes in health.

★ ★ ★

#### **45. Standardisation activity of Polish Technical Committee No. 157 for Physical Hazards in the Working Environment**

ŚWIDERSKA Mirosława, miswi@ciop.pl

Central Institute for Labour Protection – National Research Institute  
Czerniakowska 16, 00-701 Warszawa, Poland

Polish Technical Committee No. 157 was established in the Central Institute for Labour Protection – National Research Institute in the nineties as Standardisation Problem Committee. The activity scope of the Committee included noise at workstations; noise emitted by the machinery; vibrations (shocks) of mechanical components transmitted to the body of machinery operator. The secretariat of the Committee is based at the Central Institute for Labour Protection – National Research Institute. Up to now 109 Polish standards were developed by the Committee: 71 standards refer to the measurement methods and reduction of noise emission in machinery as well as noise reduction at workstations or noise measurements, 27 standards refer to measurement methods of mechanical vibrations influencing human organism. The priority for the development of standards is to implement European standards previously harmonised with the directive 98/37/EC, current directive 2006/42/EC on machinery. In general 35 standards on noise and 9 standards on vibrations are harmonised with the above-mentioned directive, whereas 11 standards on noise and 5 standards on vibrations lies in the scope of the activity of Technical Committee No. 157. International standards (ISO) are also implemented and new standards are being developed.

Technical Committee closely cooperates with technical committees of the European Committee for Standardization CEN TC 211 Acoustics, CEN TC 231 Mechanical vibration and shock as well as International Organization for Standardization ISO 43 Acoustics, ISO TC 108 Mechanical vibration and shock. Members of the Technical Committee participate in the development of European standards (preparing opinions and voting on draft standards) as well as in the implementation of standards to the Polish body of standards (6 months from the adoption of a European standard).

★ ★ ★

#### **46. The noise variability in underground room and pillar coal mine**

SZARY Marek L., szary@engr.siu.edu

CHUGH Yoginder P., ypchugh1@yahoo.com

Southern Illinois University

College of Engineering 6603

1230 Lincoln Drive, Carbondale, IL 62901

Over the last few years, manufacturers of mining machinery have improved their designs and developed new equipment that is less noisy. Noise in underground room and pil-

lar coal mine has dominant components generated mainly by three equipments/sources: a) Continuous Mining Machine (CMM) b) Roof Bolters and c) Cars/vehicles which are transporting coal and/or personnel. The CMM itself has three individual sources of noise: the cutting drum (head), the dust collector (scrubber), and the conveyor (tail). Each generates its own spectrum of noise, which interferes with the others and with the geometrical configuration of the mine opening, presenting a complex equivalent noise characteristic. Also other parameters like coal hardness and in-seam and out-of-seam rock being mined or drilled, the operators working style and experience, lowers or elevate the level of noise in the mine opening which acts as a semi-reverberant cavity. Noise data presented in this paper were collected using SPL meter and digital recorder, which has allowed for an investigation of the dynamics of noise variations in laboratory conditions. The results are presented in terms of frequency and time domains.

\* \* \*

#### **47. Railway noise problems in Poland**

SZWARC Małgorzata, reiter.m@sound.eti.pg.gda.pl

KOSTEK Bożena, bozenka@sound.eti.pg.gda.pl

Gdańsk University of Technology

Faculty of Electronics, Telecommunications and Informatics

Multimedia Systems Department

Narutowicza 11/12, 80-233 Gdańsk, Poland

In the year 2002 Directive 2002/49/EC relating to the assessment and management of environmental noise was ratified. Under this directive, all European countries are obliged to model their environmental noise levels in heavily populated areas. Some countries have their own national methods to predict noise but most of them have not created one yet. The recommendation for countries that do not have their own model is to use an interim method. For railways it is suggested to use the Dutch SRM II scheme. In the paper, aside from the Dutch model three other national methods are described and discussed. Moreover, discrepancies between HARMONOISE and IMAGINE projects are analyzed. The results and comparison with national methods are also presented in this paper.

\* \* \*

#### **48. Programme titled “MORE QUIETLY AND SAFETLY”/ “Quiet and careful” as the educational activities under the action Protection of Health against Noise. Program is addressed to the school community.**

TUREK Jolanta, jturek@mczp.pl

Mazowieckie Voivodship Office

Social Policy Department

Czereśniowa 98, 02-456 Warszawa, Poland

##### Introduction

At the onset analyzed the problem and gave reasons for its choice. Based on the study of epidemiologic and social diagnosis, own observations of schoolchildren and teachers

work environment. Discussed the schoolchildren behavior, which was the reason of health condition. Specified negative noise effects for our health as well as presented the need of delivering the information about protection of our health against this treat. Described the activities promoting mental and physical health protection of the school society against the treat which was the noise in work and school environment.

#### Aim

Estimating my own capabilities described of educational and informative activities Aimed at changing behavior and environmental conditions. Changes of both depends on many factors.

#### Material

The draft contains proposals for action multidimensional interdisciplinary. It is the first of its kind program that has educational value. Suggests Solutions problem noise hazards in the school environment focused on lifestyle changes. Uses of the various actors to improve the health and safety, hygiene, working environment a student and teacher. Includes innovative solutions in terms of ongoing changes and reforms in the field of health education.

The project contains a schedule of activities, a reasonable estimate of the expected outcomes and implementation.

#### Results

I compared the results of the following competition stages, showing the increasing interest in this issue. I discussed the activity results at other institutions. Presented the results of the screening examination of hearing in the primary school No 273 in Warsaw, Competition popularization.

#### Conclusions

I justified the need for education in the scope of health protection against noise presenting: multisectoral support of institutions, public person commitment, and creative interest of the schoolchildren in this subject.

Should be of interest to directors of schools and educational institutions. Can be implemented in schools in the so-called. pathways: pro-health, pro-environment, as part of school care program or an independent educational activities. Leading element promoting discussed above would be an art competition and recitation.

\* \* \*

### **49. Noise reduction using parallel algorithms**

WALCZYŃSKI Maciej, maciej.walczynski@pwr.wroc.pl

Wrocław University of Technology

Institute of Telecommunications, Teleinformatics and Acoustics

Wybrzeże Wyspiańskiego 27, 50-370 Wrocław, Poland

In this paper we propose a parallel version of the LMS, an algorithm which is used to digital signal processing such as echo elimination and noise reduction. LMS (Least Mean Square) filters are based on the minimization of the mean square error. These filters are stable and easy for implementation. Unfortunately, parallelization of this algorithm, especially in the distributed-memory parallel computing systems, is not so obvious. A main disadvantage of the LMS algorithm is slow convergence of this approach. There is a number of LMS variants including PNLMS (Proportional Normalized

Least Mean Square) which are focused on improving weak convergence of the original LMS method. Procedure of the filter adaptation requires a significant calculation and time cost, which has to be minimized. Faster convergence of the algorithm needs longer size of vectors used inside the filter (thousands of elements). Parallel approach allows for decomposition of the problem into a number of smaller ones, which can be computed faster. The most complex element of the computational process is the matrix multiplication procedure. By its parallelizing we obtain the concurrent algorithm which works as the sequential one, but much faster (so-called single-walk parallelization). Proposed algorithm was implemented in C++ with using CUDA and executed on 128-processors nVidia Tesla GPU. The obtained results, especially increase of speed and efficiency show, that the method is much faster than other existing procedures and it can be used in the real-time systems.

\* \* \*

## 50. Acoustic intensity imaging methods for *in-situ* wave propagation

WEYNA Stefan, weyna@zut.edu.pl

West Pomeranian University of Technology  
Al. Piastów 17, 70-310 Szczecin, Poland

Application of the sound intensity method, including the presentation of space vector distribution of acoustic power, may bring new insight into the nature of acoustic field formation in real conditions of working sources. Acoustic conditions in these areas are different from the theoretical assumptions ascribed to free or diffuse field. It is a frequent occurrence that the sound intensity measurements in real conditions may show great disparity between the theoretical assumptions of the acoustic fields distribution and the actual measurements. The disparity results mainly from simplifications accompanying the analytical methods due to lack of complete data concerning physical properties of an investigated object.

In the paper, the author has described the visualization methods in acoustic flow fields and shows how these methods may assist scientists to gain understanding of complex acoustic energy flow in real-life field. A graphical method will be presented to determine the real acoustic wave distribution in a 3D flow field. Visualization of research results are shown in the form of a *intensity streamlines* in space and as a *shape of floating acoustic wave* and *intensity isosurface* in three-dimensional space, which is unavailable by conventional acoustics metrology. In traditional acoustic metrology, the analysis of acoustic fields concerns only the distribution of pressure levels (scalar variable), however in a real acoustic field both the scalar (acoustic pressure) and vector (the acoustic particle velocity) effects are closely related. Only when the acoustic field is described by both potential and kinetic energies, we may understand the mechanisms of propagation, diffraction and scattering of acoustic waves on obstacles, as a form of energy. This attribute of intensity method can be used to validate the results of CFD/CAA numerical modeling and is very important in any industry acoustic investigations.

\* \* \*

**51. 3D sound measurements in open space**

WIERZBICKI Jacek, wierzbic@agh.edu.pl

AGH University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

The most important problem during environmental measurements in open space is connected with elimination of unwanted sound sources influence. Nowadays in most cases it is necessary to manually brake a measurement, e.g. when the dog barks. Such breaks depend on meter operator experience and made the results non-comparable. In case of sound monitoring systems with continuous data recording, the problem is more serious. The detection of sound direction as a data pre-selection should be a first step in automation of sound measurements process. The idea of such a system and first results are presented in the paper.

\* \* \*

**52. A comparison of adaptive feedforward systems  
controlling acoustic energy density estimate  
and acoustic pressure**

WILK Michał

PAWEŁCZYK Marek, Marek.Pawelczyk@polsl.pl

Silesian University of Technology  
Institute of Automatic Control  
Akademicka 16, 44-100 Gliwice, Poland

Intensive research on active noise control (ANC) done for about thirty years in many respected institutions around the world aims, among others, at extending of generated local zones of quiet. Generating a number of overlapping zones of quiet requires many measurement sets, what makes the solution uneconomic for some applications. It has been postulated in some publications that using acoustic energy density (AED) instead of acoustic pressure as the error signal, may be an effective approach. Unfortunately, AED is not measured directly, and for high precision estimation it requires expensive equipment like a sound intensity probe. This is a significant problem if ANC system is planned to work in industrial conditions, for instance in very large halls, where many people work or move inside them. It is then important to use a cheaper way to estimate AED at the expense of precision and noise control results. The aim of this paper is to examine a feedforward local ANC system with the Filtered-Reference LMS algorithm, operating to reduce squared estimate of the instantaneous energy density. Performance of such a system is compared with performance of a respective system based on acoustic pressure measurements. Experiments are performed using the data acquired in a large room representing industrial conditions.

\* \* \*

### **53. Estimation of sound level measurement uncertainty in environment, in aspect of all-weather microphones characteristics**

WSZOLEK Grażyna, wszolek@agh.edu.pl

BATKO Wojciech, Batko@agh.edu.pl

AGH – University of Science and Technology

Department of Mechanics and Vibroacoustics

Al. Mickiewicza 30, 30-059 Kraków, Poland

This paper presents an analysis of the uncertainty of the results obtained from the measurement performed by all-weather microphones.

According to mandatory law regulations, especially Environmental Law, there is a necessity to ascertain and to control environmental conditions. Sound level monitoring is performed with the aid of stations, in which all-weather microphones produced by different vendors are used. In accordance with the requirements, the monitored value must contain a measurement result with an estimate of its uncertainty. Typical sound level meters with measurement microphones must fulfill series of specific demands, and are subject to responsibility of periodical calibration under strictly specified norms. But now there is no regulation, which requires periodic calibration of meters with the all-weather microphones. Thus, despite the different weather conditions in which they work, different time of their installation at stations, as well as various types of microphones that measure different types of sounds (both in terms of spectrum and the direction of incidence of the wave) the calibration of microphones are not carried out. Also in uncertainty budgets of received results in an environment, factors concerning all-weather microphones (with all covers) are not contained, only factors concerning microphone inserts are taken into account. Uncertainty components concerning only microphone inserts are not sufficient to prepare valuation of all-weather microphone measurement uncertainty.

★ ★ ★

### **54. Diagnostic symptoms of corona audible noise in continuous monitoring systems**

WSZOLEK Tadeusz, twszolek@agh.edu.pl

AGH – University of Science and Technology

Department of Mechanics and Vibroacoustics

Al. Mickiewicza 30, 30-059 Kraków, Poland

Random character of corona phenomena in overhead AC power lines and accompanying audible noise (AN) cause that in practice, the best way to determine acoustical parameters for its evaluation is application of continuous monitoring system. However, due to large fluctuations in both the interference and the useful part of the registered signal, it is necessary to correct the choice of monitored parameters, so you can automatically calculate the indicators to assess the long-term AN from corona. Analysis of previous work shows that it is difficult to point one universal approach, such as the use of statistic levels for filtration some interference, it is necessary to simultaneously use the characteristic features of the spectrum of corona AN and the interference. Continuous measurement of the spectrum is associated with registering of a large number of data and obstacles with their gathering and processing, so it is advisable to find an optimal approach.

Paper contains some selected results of corona AN from 400 kV power line and some other parameters from the monitoring station, giving particular attention to the definition of measured parameters – acoustic and non-acoustic, to enable an automatic estimation of basic long-term indicators for corona AN assessment. Simultaneous monitoring of weather conditions, including humidity intensity of precipitation and haze (video camera), well correlated with the intensity of corona phenomena, increases the efficiency of filtering the environmental interference on the other hand, it allows the verification of computational models of corona AN as a function of rainfall.

\* \* \*

## 55. Aviation noise

WSZOLEK Wiesław, wwszolek@agh.edu.pl

AGH – University of Science and Technology  
Department of Mechanics and Vibroacoustics  
Al. Mickiewicza 30, 30-059 Kraków, Poland

Air traffic has become a factor which presents a serious ecological problem because of the noise generated, particularly in the areas surrounding the airports. In that context the problem is often described as noise pollution of acoustic climate for the environment of urban agglomerations located near the airports, The air traffic noise differs from a noise created by other sources. The differences are:

- Noise influences *relatively* large areas.
- Planes and helicopters are characterized by high levels of noise emission; however, they are at a large distance from objects, for which this noise is harmful.
- The way of a sound wave propagation (from the above) makes impossible the application of effective measures of environment protection against noises, available e.g. in road traffic.

Noise around airports limits the airport area expansion, even its location. The airport tiresomeness is especially high if it is located too close to the inhabited area. After some time, just the location becomes the reason of airports limited expansion, even its liquidation. The acoustic parameters and additionally meteo conditions should be considered in researches referred to airport noise tiresomeness.

New solutions of measuring equipment and updated computing programs become an important part in the environmental protection system in the case of the airport noise propagation monitoring and its tiresomeness.

Aviation noise aspects referring to environmental protection are presented in this paper.

\* \* \*