

Chronicle

XVI International Conference Noise Control 2013

Abstracts

Selected Issues of Vibroacoustic Protections in Rail Transport

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The article presents selected, now available in rail transport vibroacoustic protections. In the study the relationships between noise and vibration in certain frequency bands, generated due to speed of a train were discussed. The analysis of the different types of solutions for vibroacoustic protections for railways was presented, as well as the dynamic effects generated by the passing train on the commonly used noise protection equipment were examined.

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The Vibroacoustic Optimization Process of the Off-Road Machines

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In spite of the manufacturers' extensive efforts to reduce noise emission of the off-road machines especially those with intensive operating process noise, they have not succeeded. The empirical optimization process manufacturers exploit is not responding to desired limit of noise emission values. Furthermore the necessary optimization loops increase both time and costs of acoustic product development.

The effective identification of potential reduction requires sophisticated knowledge of vibroacoustic system which includes not only the noise emission but also the sound excitation and transmission. The vibroacoustic optimization process is based on three elements: designing the virtual prototypes, validation of virtual prototypes by extensive measurements, adapting and transferring the results of simulation into a real model.

The article introduces a hybrid approach developed by the KFB Polska Sp. z o.o. and IBAF Engineering GmbH, in order to obtain vibroacoustically optimised product. To illustrate that approach the article exemplarily describes the acoustic optimisation of some types of off-road machines.

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Low Cost System for Vibration Sensor Checking

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To build close systems dedicated only for one application is unfavorable from few point of view. The main of them are collection of unnecessary (duplicate) equipment and of course financial cost.

Base on this assumptions, we try to build system based on easily accessible and inexpensive components. Our system is dedicated for checking vibration sensors and rather should be used for education application. The main reason is accuracy. Our system consist of own production exciter, National Instruments data acquisition card (DAQ) and PC class computer.

Dedicated software provides us to DAQ card full control. We just select frequency band width and start test. All next steps are controlled by software. At the end of test we obtain information about each of third octave frequency in table or graph.

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Verification of the Calculation Assumptions Applied to Solutions of the Acoustic Measurements Uncertainty

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The assessment of the uncertainty of measurement results, an essential problem in environmental acoustic investigations, is undertaken in the paper. An attention is drawn to the – usually omitted – problem of the verification of assumptions related to using the classic methods of the confidence intervals estimation, for the controlled measuring quantity.

Especially the paper directs attention to the need of the verification of the assumption of the normal distribution of the measuring quantity set, being the base for the existing and binding procedures of the acoustic measurements assessment uncertainty. The essence of the undertaken problem concerns the binding legal and standard acts related to acoustic measurements and recommended in: “*Guide to the expression of uncertainty in measurement*” (GUM) (OIML, 1993), developed under the aegis of the International Bureau of Measures (BIPM). The model legitimacy of the hypothesis of the normal distribution of the measuring quantity set in acoustic measurements is discussed and supplemented by testing its likelihood on the environment acoustic results.

The Jarque-Bery test based on skewness and flattening (curtosis) distribution measures was used for the analysis of results verifying the assumption. This test allows for the simultaneous analysis of the deviation from the normal distribution caused both by its skewness and flattening.

The performed experiments concerned analyses of the distribution of sound levels: L_D , L_E , L_N , L_{DEN} , being the basic noise indicators in assessments of the environment acoustic hazards. **Keywords:** acoustic monitoring of environment, estimation of long-term noise indicators, statistical analysis results.

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Improvements of the Uncertainty Determination of the Noise Sources Identification Process

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The new method of the uncertainty calculation of the process of the noise sources identification, realised according to the method of disconnecting successive sources, was proposed in the paper. The situation, in which we are dealing with the diffuse sound field – formed by the background noise emission and the noise sources being identified – was assumed in these considerations.

In the identification algorithm were applied the mathematical formalism of the interval arithmetic, related to the measurement results of the noise level relevant to disconnecting successive sources of emission L_{s-i} [dB/A], and the noise level generated by influences of all sound sources.

The properties of the indicated solution were referred to the uncertainty calculation methods usually applied in various metrological solutions. The proposed approach was illustrated by the example realised under laboratory conditions.

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Type a Standard Uncertainty of Long-Term Noise Indicators

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The problem of estimation of the long-term environmental noise hazard indicators and their uncertainty is presented in the hereby paper. The type A standard uncertainty is defined by the standard deviation of the mean. The rules given in the ISO/IEC Guide 98 are used in the calculations. It is usually determined by means of the classic variance estimators, under the following assumptions: the normality of measurements results, adequate sample size, lack of correlation between elements of the sample and observation equivalence. However, such assumptions in relation to the acoustic measurements are rather questionable. This is the reason why the authors indicated the necessity of implementation of non-classical statistical solutions. There is formulated the estimation idea of seeking density function of long-term noise indicators distribution by the kernel density estimation, bootstrap method, and Bayesian inference. These methods do not generate limitations for form and properties of analyzed statistics. The theoretical basis of the proposed methods is presented in this paper as well as the example of calculation process of expected value and variance of long-term noise indicators L_{DEN} and L_N . The illustration for indicated solutions and usefulness analysis were constant monitoring results of traffic noise recorded in Cracow, Poland.

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Soundscape of Polish National Parks

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The aim of the research, which has been taken up in Polish national parks is to identify threats connected with noise, recognize soundscape resources, indicate opportunities of their protection. Studies were carried out with the use of surveys which help to diagnose awareness of threats and values of soundscapes among service of parks. Additionally, method of semantic differential was applied, just to learn opinion of students, concerning quality of soundscape in Polish national parks. Except for empirical studies experience in protection of soundscapes in national parks of the US were presented. Finally, possibilities of future research on soundscape in areas of high natural values were pointed out.

Keywords: landscape perception, soundscape, quiet zone, national parks.

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Evaluation of Influence of Work Analysis Data on Determination of Occupational Noise Exposure in Accordance with Standard PN-EN ISO 9612:2011 for Mechanic – Welder Workstation

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In article authors present results of determination of occupational noise exposure (performed in accordance with standard PN-EN ISO 9612:2011) for mechanics – welders working in one of manufacturing plant in Poland. Main goal was to verify previous results obtained using task-based measurements (strategy 1). For this purpose an additional measurement session with full-day measurement (strategy 3) was performed, extended by highly detailed recording of work activities and their duration. Emphasis was placed on matter of determination and identification of tasks and tools usage. Analysis of collected results led to evaluation of influence of work analysis data on determination of occupational noise indicators. Finally, for both strategies, the comparison of the contribution from each identified task to daily noise exposure level was made.

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The Use of GIS Data in the Acoustic Models – Processing of Data Obtained or Prepared to Adapt Them to the Local Law Requirements which Performers of an Acoustic Projects Have to Fill

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The paper initially describes the purpose of the use of GIS data used in the models created for the purpose of acoustic noise maps for cities with a population of over 100 thousand inhabitants performed on the basis of Directive 2002/40/EC and the most popular data formats.

It then provides necessary format conversion and commonly used for this purpose methods to the minimum loss of data. While describing the format conversions most frequently used computer programs were mentioned.

The first step in describing the work of the GIS data is to prepare the data obtained to import them into the acoustic software, and therefore presents the computational requirements of

the models as to the scope of GIS data, file formats and structure of tabular attributes of individual thematic layers together with a description of the process of data processing. The paper also includes data fusion capabilities of GIS with the results of acoustic measurement collected in such a way as to permit the implementation of direct importation into acoustic programs such as CadnaA or IMMI.

Then the need to verify the data entered was identified and different ways to carry out the process were suggested. At the stage of verifying the description of GIS data the most common mistakes and ways to exclude them were indicated.

The paper also describes ways to export the acoustic data to the most common file formats and the most common deficiencies which can occur during this process in relation to the layer attributes associated with sources of industrial noise, road and rail – deficiencies in most commercially available applications for modeling environmental noise were indicated.

There also have been described frequent requirements asked by the government about the data both for reporting on the implementation of noise map for internal use, along with the methods of processing the results of acoustic analysis in such a way that all the requirements are met.

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The “NOMAD” Project – A Survey of Instructions Supplied with Machinery with Respect to Noise

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The NOMAD project was a survey to examine the noise-related content of instructions supplied with machinery offered for purchase in Europe. The project collected more than 1 500 instructions from machines covering 40 broad machine-families and from 800 different manufacturing companies. These instructions were analyzed to determine compliance with the requirements of the Machinery Directive, and assess the quality of information.

The general state of compliance of machinery instructions with the noise-related requirements of the Machinery Directive was found to be very poor: 80% of instructions did not meet legal requirements. Some required numerical values relating to noise emissions were often missing. Where values were given, they were often not traceable to machine operating conditions or measurement methods, and not credible either against stated conditions/methods or as warnings of likely risk in real use.

As a consequence, it is considered highly likely that, in making a machinery procurement decision, employers are prevented from taking noise emissions into account, and understanding what is necessary to manage the risks from noise relating to equipment that is procured.

Recommendations are made for actions aimed at bringing about a global improvement to the current situation. Targeted actions are now proposed by “ADCO Machinery Group” aimed at raising awareness of the legal requirements, responsibilities and actions required among the various groups who have parts to play in the system – machine manufacturers, machine users, occupational safety and health professionals, and standards-makers. Recommendations are also made aimed at providing, or improving, tools and resources for all these actors.

Keywords: noisy machine, machinery directive, legal requirements, survey.

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Selection of Sound Insulating Elements in Hydraulic Excavators – on the Basis of the Identification of Vibroacoustic Energy Propagation Paths

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In spite of the fact that standardising operations and increased awareness of hazards led to a significant improvement of vibroacoustic climate of operator’s stands of new machines, their long-term exploitation – often under difficult conditions – leads to a fast degradation of acoustic qualities of machines. Temporary operations, performed during surveys and periodical overhauls are rarely effective, due to the lack of any guidelines. In this situation the authors propose the algorithm – of selection of eventual screens or sound absorbing and sound insulating partitions – utilizing the measuring procedure of an identification at the operator’s stand, of main noise components originated from various sources. On the basis of this procedure the vibroacoustic energy propagation path in the machine was estimated.

Keywords: noise and vibration, propagation path, coherence function.

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The Apparatus Intended for Measurement of Ultrasonic Noise and the Capabilities of Its Traceable Calibration

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Measurements of airborne ultrasounds still encounter a lot of unsolved problems concerning the apparatus and measurement traceability. The lack of measurement standards and standardised primary methods of reproduction of sound pressure unit in ultrasound frequency range is essential. Another important problem is the lack of the internationally agreed requirements for the apparatus intended for the measurement of ultrasonic noise. In this paper the results of the review and analysis of the characteristics of the instruments available on the market, crucial for ultrasonic noise measurement are presented as well as the current capabilities of ensuring the measurement traceability. Temporary recommendations regarding the apparatus and the methods and programme of its periodic calibration are also presented.

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The Influence of Apparatus Parameters on the Uncertainty of Ultrasonic Noise Measurement

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Ultrasonic noise is a harmful factor to health in a working environment. For that reason it is necessary to assess risk arising from ultrasonic noise. However, for the frequency range above 20 kHz, there is no clear and complete information on the factors influencing the result of a measurement of the sound pressure level. What is more, there are no current international standards for performing measurements of ultrasonic noise in working environment. This paper presents the methodology for estimating combined uncertainty related to the apparatus used for measurements of ultrasonic noise at work places. The methodology

comprises the identification of main quantities influencing the uncertainty, the detailed methods for evaluating standard uncertainties of these quantities, collation of the significant sources of uncertainty in the form of the uncertainty budget and the calculation of combined standard uncertainties.

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Preliminary Study on the Influence of Headphones for Listening to the Music on Hearing Loss of Young People

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The paper presents results of hearing loss measurement provided for over than 80 young people (from 16 to 25 years old). The main aim of the work was to find an influence of type of used headphones (closed, semi-open, open and in-ear) on the hearing losses. The first part of the research was to answer questions of: time of listening, loudness of the music, the other noise exposures as well as the type of used headphones. It turned out that all factors mentioned above influence thresholds of hearing but the found dependencies are not explicit. The greatest hearing losses were observed for the people who work as sound reinforcement engineers and, moreover, no influence of headphones type was found for them. It turned out that the use of in-ear headphones causes the greatest hearing losses for some subjects (thresholds shifted up to about 20 dB at 4 kHz). The daily time of a listening also affected hearing thresholds and it was found that for users of in-ear and close headphones, an average time of musical exposure was of three hours and it causes the hearing loss of 10–15 dB at higher frequencies. The use of open as well as semi-open headphones has no influence on hearing damage and it would be stated that these kinds are safety in use. Almost 15% of investigated young people have their thresholds shifted up at higher frequencies, particularly at 4 kHz what means that they have the first symptoms of the permanent hearing damage.
Keywords: hearing threshold, headphones.

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Does Exposure to Sounds During Individual Rehearsals Increase the Risk of the Hearing Loss in the Orchestral Musicians?

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In order to evaluate musicians' exposure to orchestral noise during solo and group rehearsals, the field studies were carried out in three symphony orchestras.

The load of musicians playing instruments was evaluated using a questionnaire survey. The survey was performed in the group of 57 musicians to identify a typical playing times of individual and collective rehearsals or concerts. Weekly time of playing instruments is divided between performances, team and individual rehearsals 2.5, 20, and 7.5 hours, respectively.

The noise exposure of various groups of instruments was measured during preparations to perform diversified repertoire. The measurements were performed during the individual playing and collective playing. Equivalent sound pressure levels recorded during individual practicing were higher than in the case of team play in the woodwind and brass instruments, while similar levels were recorded for the string instruments.

Majority musicians, excluding stringed instruments players, were exposed to excessive sounds exceeding Polish maximum admissible intensity value (85 dB).

Exposure during both individual and group rehearsals should be taken into account in the hearing conservation program for this staff group.

Keywords: noise measurement, noise exposure, orchestral musicians.

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Exposure to Excessive Sounds During Orchestra Rehearsals and Temporary Hearing Changes in Hearing Among Musicians

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The harmful effects of exposure to orchestral noise may include the prevalence of temporary changes in hearing.

The temporary changes in hearing after group rehearsals were determined in musicians using transient-evoked otoacoustic emissions (TEOAEs). The study group comprised 19 orchestral musicians, aged 30–58 years (mean 40 years) having from 12 to 40 years (mean 22 years) of professional experience.

Musicians' hearing threshold levels were higher than expected for the non-noise-exposed population. Moreover, the high frequency notched audiograms were observed in some of them.

No significant differences between pre- and post-exposure reproducibility of TEOAE and signal to noise ratio were found. However, the significant post-exposure reductions of TEOAE amplitudes (approx. 0.7 dB) both for the total response and frequency bands of 2000 and 3000 Hz were noted.

Keywords: orchestral musicians, temporary changes in hearing, transient evoked otoacoustic emission.

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Two Stage Vibration Isolation on Example of a Vibratory Conveyor

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In this paper the effectivity of two stage vibration on example of the vibratory conveyor has been shown. Vibratory conveyors are used i.e. for coal transportation in power stations. In the considered case the conveyor has been supported on the ceiling in 1st floor of the building and caused vibrations. For identification of dynamical behavior of the conveyor, vibrations measurements and simulation have been carried out. To reduce the transmission from the conveyor to the ceiling two stage vibration isolation has been performed and significant reduction of vibrations in the building has been achieved.

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Model of Interactive System for Training in the Proper Use of Hearing Protection Devices

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In 2011, over 520 thousand persons worked in hazardous conditions (according to the GUS). Among hazardous factors related to working environment, noise was found to be the most common threat, which threatened 199,6 thousand persons (52.9% threats-cum-persons related to working environment). The prevalence of workplace noise and increasing awareness of effects of its impact on the human body causes increase of the demand for knowledge of the methods of noise reduction. Due to the lack of knowledge concerning the proper use of hearing

protectors, effective noise exposure in the real world may be about a dozen dB higher than the declared assumed protection value. For this reason, in Central Institute for Labour Protection – NRI “The interactive system to learn the correct use of hearing protectors” had been developed. The system includes the multimedia guide on hearing protectors supplemented by video tutorials, training materials with training hearing protectors, and software for evaluation of the activities of the trainee.
Keywords: active noise reduction, hearing protectors.

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Noise Exposure of School Teachers – Exposure Levels and Health Effects

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Faculty of Natural and Technical Sciences and Faculty of Medical Sciences starting from December 2012, launched joint study in order to investigate personal noise exposure and associated health effects in general school teachers population, starting from kindergartens up to high schools in Stip, Macedonia.

In order to determine workplace associated noise exposure and associated health effects in this specific profession, a full shift noise exposure of 40 teachers from 1 kindergarten, 2 primary and 2 high schools were measured in real conditions using noise dosimeters.

A-weighted equivalent-continuous sound pressure levels (L_{Aeq}) of each teacher were recorded during single activities (classes). Normalized 8-hours exposure, termed the noise exposure level ($L_{ex,8h}$) was also computed. Daily noise dose is another descriptor for noise exposure that was determined as a measure of the total sound energy to which workers have been exposed, as a result of working in the varying noise levels.

Health effects were assessed through a full scale epidemiological study which included 231 teachers from the same schools. Specific questionnaire was used to extract information about subject's perception on occupational noise exposure, as well as their occupational and medical history.

Keywords: teachers, school, noise, exposure, health effects.

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Influence of Infrasound Noise of Wind Turbines on EEG Signal

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The purpose of this paper is to determine the effect of infrasound noise of wind turbines (up to 20 Hz) on the changes in the morphology of the EEG signal. 35 subjects had undergone 20 minute exposure infrasound noise in the cabin pressure. The acoustic signal recorded at a distance of 750 meters from a wind turbine, then filtered frequency components above 20 Hz. So processed audio signal of the test were presented. The parameters of the presented signal SPL = 91.6 dB(LIN), SPL = 39.2 dB(A).

The study proceeded in three stages. Step one – five minutes without exposure of the acoustic signal. Step two – twenty-minute exposure of infrasound noise. Step three – ten minutes without exposure of the acoustic signal. The study was conducted in cabin pressure during the whole study was recorded EEG signal. Uses 19 electrodes placed on the head of the test system by 10–20.

The results of the initial EEG was analyzed in order to remove artifacts. Then the calculated power spectral density func-

tions, uses 8-second window, overlapping 50%, and the window Hanninge. The results were averaged for subsequent phases of the study. An analysis of the EEG signal changes in morphology between the three successive stages of the study.

The obtained results allowed to demonstrate changes in the morphology of the EEG signal during exposure of infrasound noise from wind turbines. Found changes in specific frequency ranges of the EEG signal.

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New Look at Management of Noise in Natural Environment

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It is recently observed that the sound layer is more and more polluted with noise, in particular in the urbanized areas. This hazard is being generated, to a large extent, by road transport. The investigations currently conducted at the road tests sites provide a basis for a trial to take actions important for a proper shaping of the acoustic climate in inhabited areas. Making an effort to meet this hazard, acoustic barriers are constructed to the greatest extent exposed to road traffic noise. However, it should be added that this is only a beginning of a certain process in which urban development, architectural and building methods, and legal-administrative actions should also be taken into account. But, in the course of designing acoustic screens, only their effectiveness is considered, omitting the aesthetic attributes and harmony in the landscape.

Making a reference to the statements of the European Landscape Convention on protection of landscapes, which includes the protection of views, one should conclude that it is necessary to take into account such things as their acoustic effectiveness in the area, and composition and aesthetics in the landscape. These actions are considered to be found at the border line between art (when taking care of aesthetic quality of sound environment), and science (including, among the other things, acoustics, landscape architecture, urban development, musicology, and psychology).

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Proposals for Noise Control Measures in Opencast Mineral Mines

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Exploitation of open-pit mines of minerals constitutes vibroacoustic hazards for their workers and inhabitants living near such establishments. Noise, being one of the main harmful factors in work environment, is a threat to the external environment, particularly when mining works are carried out near residential areas or reserves.

The quarry industry is connected with many noisy activities. There are: drilling, blasting works, crushing of rocks and aggregate screening and transport of mineral materials. The operators of mining and transport machines as well as servicing and technical inspection workers are the most endangered to noise. Exceeding level of noise is the reason of occupational diseases, distortions of speech intelligibility among workers and accidents at work.

General technical solutions, concern noise level reduction in open-pit mines of mineral raw materials, are given in the paper.

Some propositions of conceptions of noise protections, connected with operating of machines, which are mobile crushers, are also shown.

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A Dedicated Preamplifier for Vibration Transducer Made of PVDF Film

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PVDF film transducers belonging to smart materials group are increasingly applied to the measurement of the mechanical vibration. The article presents the concepts and sample of laboratory test results of preamplifier intended for measuring of vibration at workstations using PVDF film. Developed preamplifier based on instrumental amplifier and on charge buffer. Regardless of the value of the transducer's capacity the charge buffer provides the constant transmission at lower frequency in the measuring system. The use of the reference transducer can effectively minimize the disturbance of the desirable signal. Preliminary laboratory measurements have confirmed the proper operation of the preamplifier.

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Acoustic Maps Before and After Change of Levels Permitted Noise

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Acoustic maps of towns are developed in accordance with the Directive 2002/49/EC. The directive says that each Member State of the European Union determines limit values of noise indicators for different noise sources as well as different surroundings. The limit values in Poland for road- and rail-noise determined in 2007 were relatively low compared to other countries. These values have been significantly increased in October 2012 for two basic noise indicators, L_{den} (L_{DWN}) and L_{night} (L_N), by 5–10 dB, depending on the surroundings. The impact of these changes on estimated town areas and numbers of inhabitants exposed to the road- and rail-noise in seven Polish towns (3 towns with more than 250 000 inhabitants and four towns with more than 100 000 inhabitants) has been investigated based on results of acoustic maps. Non-dimensional results (standardization with regard to the total town area and total number of inhabitants) for the former (more restrictive) and the recent values of limits were compared using the same methodology. Analysis revealed that on average, the estimated number of inhabitants exposed to noise levels exceeding the limit values decreased by 90%.

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Effects of Acoustic Treatment on Music Teachers' Exposure to Sound

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In this study, music teachers' exposure to sound was tested by measuring the *A*-weighted equivalent sound pressure level (SPL), the *A*-weighted maximum SPL and the *C*-weighted peak SPL. Measurements were taken prior to and after acoustic treatment in four rooms during classes of trumpet, saxophone, French horn, trombone and percussion instruments. Results showed that

acoustic treatment affects the exposure of music teachers to sound. Daily noise exposure levels ($L_{EX,8h}$) for all teachers exceeded a limit of 85 dB while teaching music lessons prior to room treatment. It was found that the $L_{EX,8h}$ values ranged from 85.8 to 91.6 dB. The highest *A*-weighted maximum SPL and *C*-weighted peak SPL that music teachers were exposed to were observed with percussion instruments ($L_{Amax} = 110.4$ dB and $L_{Cpeak} = 138.0$ dB). After the treatments, daily noise exposure level decreased by an average of 5.8, 3.2, 3.0, 4.2 and 4.5 dB, respectively, for the classes of trumpet, saxophone, French horn, trombone and drums, and did not exceed 85 dB in any case.

Keywords: music teachers, sound pressure levels, acoustic treatment.

* * *

Temporary Threshold Shift and Hearing Loss for Recording Engineers

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The paper presents results of Temporary threshold shift measurement provided for over than 30 recording engineers. The main aim of this article is to provide information and explanation of these phenomena to understand basic principles and to help understand how to work more effectively and efficiently in the recording studio.

Noise exposure and intense sounds can cause two main types of hearing loss, temporary threshold shift and permanent threshold shift. This protection mechanism is responsible for sensitivity reduction, causing the hearing threshold to shift upward. Permanent threshold shift occurs during regular exposure to excessive noise for long periods of time.

Listening to loud music, which is an integral part of working in the recording studio, can cause a temporary loss of hearing in the mid frequency region. In one study, a group of 30 recording engineers were exposed to near-field sound at LEQ 93.6 dB, MAX 102.6 dB for 90 minutes. For all the people who attended in the tests was observed hearing threshold shift. The biggest changes were measured for frequency 4000 Hz and reached up to 10–20 dB. More than a half of the people also experienced 5–10 dB changes for 2000 and 8000 Hz. None showed a loss above the guideline at 1000 Hz or 8000 Hz, so the shifts are concentrated in the maximum sensitivity range of human hearing.

To ensure the comfort of working in a recording studio it is necessary to take regular breaks and thus avoid continuous exposure to loud sounds. This is the key to keep fresh ears and a fresh perspective in your music.

* * *

Active Noise and Vibration Control System Based on a TMS320C6747 Floating Point Digital Signal Processor

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In this paper an early stage of the design of an active noise control system based on the TMS320C6747 is presented. Aim of the article is to introduce capabilities of the system and its limitations. Purpose of the system are in-situ situations, where the system can be applied immediately without measurements and system/signal analysis using PC and special software. Results of example laboratory tests of active noise control process using genetic algorithm and neural network are also presented.

* * *

Land-Use Planning Methods in Environmental Acoustics. Towards to “Quiet zones”

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One of the most effective methods in environmental noise control is the adequate land-use technique. In fact, this method comes into effects rather in medium or even long-term perspective. The results of the noise mitigation activity using land-use process require the common indexes, classifications, assessment methods of different impacts (non-acoustic too) etc.

The paper orders the background relations between noise control and land-use techniques (main, but chosen examples) with the special emphasis laid down on the basic descriptors (indexes). The relations will be developed in the quantitative form (if possible) as well as in qualitative (descriptive) forms.

One of the most important issue on the field of environmental control is the prevention. This activity is indirectly connected with the so called “quiet areas” (zones). Present definition of the “Quiet zone” (in agglomeration) is enclosed in the Directive 2002/49/EU (DEN) (art. 3, point “I”):

“quiet area in an agglomeration” shall mean an area, delimited by the competent authority, for instance which is not exposed to a value of L_{den} or of another appropriate noise indicator greater than a certain value set by the Member State, from any noise source”.

The paper includes the preliminary short proposition of the “quiet zone” creation, of course by adoption of the land-use techniques.

At the end the conception of the “quiet zones” recovering technology is presented.

* * *

Railway Noise Measurements and Assessments in Poland. The State-of-Art Before Railways Lines Upgrading

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Railway noise is one of components of the environmental soundscape of Poland. The field measurements of the railway noise exposition were carried out during last 10 years. The results of them (few hundred’s pieces) were used in different studies and analyses, especially in Environmental Impact Assessments as well as in noise mapping process.

DEN requirements point out that the appropriate method for the railway noise assessments is the SRMII (Dutch method). The methods include the reference library of the acoustic parameters of different kinds of trains. These data is not suitable for polish trains vs. polish rail-tracks.

In the paper the state-of art of railway noise exposition arise from the results of field measurements is presented. The measurements were mostly done around the present railways, aged few dozen years (tracks and rolling stocks). The results were compared with the noise calculations (SRMII).

On the base of comparisons the analysis of differences will be done taking into consideration expected upgrading (fulfill international conditions) many of railway’s lines in Poland. Some examples between noise exposition before and after upgrading of the tracks added to the presentation.

* * *

Active Noise Control Using a Fuzzy Inference System Without Secondary Path Modeling

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For many adaptive noise control systems the Filtered-Reference LMS, known as FXLMS algorithm is used to update parameters of the control filter. Appropriate adjustment of the step size is then important to guarantee convergence of the algorithm, obtain small excess mean square error, and react with required rate to variation of plant properties or noise nonstationarity. There are several recipes presented in the literature, theoretically derived or of heuristic origin.

This paper focuses on developing a modification of the FXLMS algorithm, where convergence is guaranteed by changing sign of the algorithm steps size, instead of using a model of the secondary path. The Takagi-Sugeno-Kang fuzzy system is used to evaluate both the sign and the magnitude of the step size. The proposed approach is compared with the classical FXLMS algorithm by means of simulation experiments in terms of convergence and noise reduction.

Keywords: index terms, active noise control, adaptive control, fuzzy inference system, FXLMS, sign-varying step size.

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Latest Developments in International Standardization of Whole-Body and Hand-Arm Vibration

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New developments in international standardization of whole-body and hand-arm vibration are presented.

Two German projects are addressing both subjects at the same time: one is concerned with the uncertainty in vibration measurement, the other is dealing with the qualification of personnel responsible for the exposure measurement and risk assessment at work places.

In the field of whole-body vibration, the measurement standard ISO 2631-1 is currently under revision. The main activities are concerned with comfort effects. In addition, ISO/TR 10687 has been published recently which describes posture variables that should be reported when a combined exposure of whole-body vibration and awkward posture is investigated. The effect of shocks as described in ISO 2631-5 is also under revision, where two procedures are proposed. One of them is already available as DIN SPEC 45697.

As far as hand-arm vibration is concerned, one can find the effect of coupling forces in the recently published CEN/TR 16391. Also DIN 45679 for the same subject has been revised in 2013, including also information available in ISO 15230. In addition, the frequency weighting for hand-arm vibration regarding vascular disorders is under discussion in an ISO working group. Finally, the standards for the assessment of vibrational emission of handheld power tools has been revised under EN ISO 28927 and replaces ISO 8662.

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Economic Aspects of Using Acoustic Maps

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The main project in the domain of environmental acoustics, executed over the last decade, were the activities related to working out the strategic acoustic maps for the cities with population exceeding 100 thousand, as well as those for main roads

and railways. The works conducted for the cities with a number of inhabitants over 250 thousand, and international-importance roads and railways have been completed, while the acoustic maps for the cities with population of 100–250 thousand are still under preparation. These documents have been gradually sent to the EU Central Office in Brussels. The expenditures on elaboration of the maps for the first groups of cities were about 24 million Polish zloty. It is estimated that a total cost of the entire project, as a consequence of the provisions of the UE Directive No. 49 and Polish Environmental Act, will be higher than 100 million zloty. The acoustic maps are considered to provide a basis for preparing programmes of protection against excessive environmental noise. Do they really serve this, and are they able to do this? The paper presents the author's reflection relative to economic consequences of programming the actions to reduce the environmental noise on the background of such actions being taken in other EU countries.

* * *

Measurements of Ultrasonic and Audible Noise During Ultrasonic Welding of Metals

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This article presents the results of measurements of sound pressure level in 1/3 octave bands of ultrasonic noise and audible noise during ultrasonic welding of different metals. Research was carried out on the experimental work station in Welding Institute during ultrasonic welding of monomial joints like copper + copper, aluminium alloy + aluminium alloy and heteronymous joints like copper + aluminium alloy. The research was conducted during ultrasonic welding in 2 options: with and without housing. The article also presents the results of simulation of 8-hour working day exposure on ultrasonic and audible noise at hypothetical work station. Simulation was conducted by random sampling MonteCarlo method using Crystal Ball 2000 software.

The measurements' results showed that sound pressure level in 1/3 octave bands of ultrasonic noise during ultrasonic welding of metals depends on type of welded materials: the highest equivalent sound pressure level in dominant 1/3 octave band of ultrasonic noise with the center frequency 20 kHz occurs during ultrasonic welding of monomial joints Al + Al type and the lowest during ultrasonic welding of heteronymous joints Cu + Al type. During ultrasonic welding without housing the highest equivalent sound pressure level in dominant 1/3 octave band of ultrasonic noise with the center frequency 20 kHz occurs in the place of operator's work in front and back of welding device. Working places located on both sides of welding device were characterized by lower sound pressure levels.

* * *

Active Noise Control with a Single Nonlinear Control Filter for a Vibrating Plate with Multiple Actuators

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Vibrating plates can be used in Active Noise Control (ANC) applications as active barriers or as secondary sources replacing classical loudspeakers. The system with vibrating plates, especially when nonlinear MFC actuators are used, is nonlinear. The nonlinearity in the system reduces performance of classical

feed-forward ANC with linear control filters systems, because they cannot cope with harmonics generated by the nonlinearity. The performance of the ANC system can be improved by using nonlinear control filters, such as Artificial Neural Networks or Volterra filters.

However, when multiple actuators are mounted on a single plate, which is a common practice to provide effective control of more vibration modes, each actuator should be driven by a dedicated nonlinear control filter. This significantly increases computational complexity of the control algorithm, because adaptation of nonlinear control filters is much more computationally demanding than adaptation of linear FIR filters.

This paper presents an ANC system with multiple actuators, which are driven with a single nonlinear filter. To avoid destructive interference of vibrations generated by different actuators the control signal is filtered by appropriate separate linear filters. The control system is experimentally verified and obtained results are reported.

Keywords: active noise-vibration control, active structural acoustic control, adaptive control, nonlinear-control.

* * *

A Two-Layer Adaptive Active Structural Noise Control System

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Vibrating plates have been gaining increasing interest for active noise reduction or isolation systems. Unfortunately, they are much harder to control than loudspeakers. Plates have multimodal response with high variations of amplitude response. To effectively excite multiple vibration modes multiple actuators are usually needed. Using multiple actuators mounted on a single plate significantly increases the number of control signals to be worked out. This could be a severe problem for active control systems with multiple vibrating plates. Such system would have a large number of secondary paths and necessity to adapt many control filters. However, secondary paths for the same vibrating plate are not fully independent. In this paper a lower-layer single-input multiple-output controller is designed first for the vibrating plate to be seen as a single-input single-output plant of equalized frequency response. Then, a higher-layer active controller is designed to reduce noise. The control system is experimentally verified and obtained results are reported.

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Influence of Electrical and Magnetic Field at 50 Hz on Values Indicated by Noise Measure Instruments

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To assess of occupational risk at workplaces as a result of exposition of noise, it is necessary to perform credible measurements of noise. One of the elements of reassurance reliability of measure instruments' indications is using them in specific operation's conditions.

In the article shows the results of the effect of 50 Hz electromagnetic fields of high intensity on noise measure instruments' indications. Research was conducted on two noise measure instruments: noise dosimeter with microphone in ear canal and sound level meter. Both instruments were situated in magnetic and then electric field of 50 Hz frequency. Research was conducted for intensity fields from 0 to value higher than NDN on workplaces. It was certified in the research's results that both instrument were sensitive to both fields. It was also certified that essential difference of indications *A*-weighted sound pressure level, from the reliability of the research's results point of

view is 3 dB. Electrical field, on which employees could be exposed on workplaces, was not higher than this value. Magnetic field for sound level meter was also not higher than this value as well as for noise dosimeter, but only for field value up to 800 A/m. According to regulations employers could abide in field up to 2000 A/m for short periods of time, because of this fact in the areas where intensity of magnetic field is between 800 and 2000 A/m the research's results contain unacceptable errors. Taking range and form of the experiment into account, it is advisable to treat obtained results as indication of significance heretofore omitted factor, that affects reliability of noise measure and as foothold for further research in this matter.

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Influence of Classrooms' Acoustic Treatment on Background Noise Level and Teachers Voice Intensity

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Noise is one of the indirect reasons of teachers' voice illnesses. It is the result of unintentional speaker's tendency to augment "voice intensity" to improve audibility in noisy surrounds. This effect is called Étienne Lombard's effect. It follows that decreasing the background noise can indirectly affect to teachers to reduce voice intensity. Decreasing the background noise can have positive influence on reducing teacher's voice occupational disease. The article verified that thesis. Sound-absorbing materials have been used as an element to decrease background noise (coming mostly from students).

Main conclusion from the studies is the fact, that acoustic treatment of classrooms (ceiling and parts of side walls) can decrease background noise and decrease teachers' voice intensity at 5-10dB, which consequently contribute to decrease excessive strain of teachers voices – main cause of most popular occupational disease in this occupational group.

* * *

Assessment of Impulse Noise Hazard and the Use of Hearing Protection Devices in Workplaces where Forging Hammers are Used

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The impulse noise is agent harmful to health not only in the case of shots from firearms and the explosions of explosive materials. This kind of noise is also present in many workplaces in the industry. The paper presents the results of noise parameters measurements in workplaces where four different die forging hammers were used. The measured values of the *C*-weighted peak sound pressure level, the *A*-weighted maximum sound pressure level and *A*-weighted noise exposure level normalized to an 8 h working day (daily noise exposure level) exceeded the exposure limit values. For example, the highest measured value of the *C*-weighted peak sound pressure level was 148.9 dB. Due to the lack of possibility to use other methods for reduction the impact of impulse noise, workers present at considered workplaces have to wear hearing protection devices. In this study possibility of the protection of hearing with the use of earplugs or earmuffs

was assessed. The measurement method for the measurements of noise parameters under hearing protection devices using an acoustical test fixture instead of testing with the participation of subjects was used. The results of these measurements allows for assessment which of two tested earplugs and two tested earmuffs sufficiently protect hearing of workers in workplaces where forging hammers are used.

* * *

Internet Service BEZPIECZNIEJ Dedicated to Noise, Vibration and Other Physical Agents of Working Environment

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According to statistical data, a few hundred thousand of workers in Poland works in hazardous conditions caused by physical agents, like for example noise, vibration, electromagnetic fields or optical radiation (ultraviolet, visible and infrared). Working in hazardous conditions can lead to occupational diseases of workers, as well as cause industrial accidents. As one of the most important method of hazards prevention is education, it requires easy accessible educational materials, suitable for persons of different skills and degrees of education. An internet service BEZPIECZNIEJ (in English: SAFER) was developed as a system for supporting prevention of occupational hazards caused by physical agents. Service BEZPIECZNIEJ, available from main web portal of the Central Institute for Labour Protection – National Research Institute, consists of information and educational materials prepared by panel of experts and related to particular physical agents. In this article the structure and the contents of the service will be presented based on examples of noise and vibration hazards.

* * *

Acoustical Quality Assessment of Sports Facilities

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The aim of this paper is to present a method for the assessment of the acoustical quality index of sports enclosures in the design stage, which takes into consideration the selection of the architectural and acoustical parameters. The paper describes the proposed method for assessing the acoustical quality indicator of sports enclosures. The method consists of compiling and analyzing the proper selection of architectural and acoustical parameters (including reverberation time, and decay regimes of the absorption or scattering of sound). The result is a single number – sports facilities sound quality evaluation index, which can be used during the design of sports facilities. The method attempts to develop a rapid and simple procedure for estimating the initial acoustical conditions in such rooms in order to ensure the sound quality and the intelligibility of speech in the rooms.

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Assessment of Annoyance Due to Wind Turbine Noise

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The overall aim of this study was to evaluate the perception and annoyance of noise from wind turbines in populated areas of Poland.

A questionnaire inquiry on response to wind turbine noise was carried in 363 subjects living in the vicinity of wind farms.

In addition, current mental health status of respondents was assessed using Goldberg General Health Questionnaire GHQ-12. For areas where respondents lived, *A*-weighted sound pressure levels (SPLs) were calculated as the sum of the contributions from the wind power plants in the specific area. Noise conditions outside the dwellings were verified by *in situ* measurements.

It has been shown that the wind turbine noise at the calculated *A*-weighted SPL of 27–49 dB was perceived as annoying outdoors by 32.8% of respondents, while indoors by 20.5% of them. The odds ratio of being annoyed outdoors by wind turbine noise increased with increasing SPLs (OR = 2.1; 95%CI: 1.22–3.62). Subjects' attitude to wind turbines in general and sensitivity to landscape littering was found to have significant impact on the perceived annoyance. About 52% of variance in annoyance assessment outdoors might be explained by the aforesaid subjective factors. Further studies are needed before firm conclusions can be drawn.

Keywords: wind turbines, noise, annoyance

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A Questionnaire for Assessment of Annoyance Due to Wind Turbines

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A special questionnaire was developed in order to evaluate the subjective response to noise from the wind turbines in people living in their neighborhood. This questionnaire was aimed at evaluation of respondents' living conditions, including prevalence of annoyance due to wind turbine noise, and the self-assessment of physical health and wellbeing.

The questionnaire consists of two parts. The first one comprised inquiries concerning: a) housing and satisfaction with the living environment, including questions on occurrence and the degree of annoyance experienced outdoors and indoors from various nuisances, b) sensitivity to odors and air pollution, landscape littering, c) general opinion on wind turbine and on the visual impact of wind turbines, d) different visual and auditory aspects of wind turbines, such as noise, shadows and reflections from rotor blades, during various subjects' activities and weather conditions. The second part of the questionnaire was aimed at self-assessment of subjects' physical health, including hearing status. It also comprised questions on chronic illnesses and general wellbeing, as well as quality of sleep and normal sleep habits.

Statistical analysis of results of questionnaire inquiry in study group of 156 subjects living in the vicinity of wind farms confirmed a high internal consistency of different questions evaluating response to wind turbines by Cronbach's α coefficient of 0.93.

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Evaluation of Efficiency of Personal Hearing Protective Devices in Case of Exposure to Ultrasonic Noise

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living environment, including questions on occurrence and the degree of annoyance experienced outdoors and indoors from various nuisances, b) sensitivity to odors and air pollution, landscape littering, c) general opinion on wind turbine and on the visual impact of wind turbines, d) different visual and auditory aspects of wind turbines, such as noise, shadows and reflections from rotor blades, during various subjects' activities and weather conditions. The second part of the questionnaire was aimed at self-assessment of subjects' physical health, including hearing status. It also comprised questions on chronic illnesses and general wellbeing, as well as quality of sleep and normal sleep habits.

Statistical analysis of results of questionnaire inquiry in study group of 156 subjects living in the vicinity of wind farms confirmed a high internal consistency of different questions evaluating response to wind turbines by Cronbach's α coefficient of 0.93.

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Noise-Induced Hearing Loss in Professional Orchestral Musicians

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The overall purpose of this study was to assess hearing status in professional orchestral musicians. Standard pure-tone audiometry (PTA) and transient-evoked otoacoustic emissions (TEOAEs) were performed in 126 orchestral musicians. Occupational and non-occupational risk factors for noise-induced hearing loss (NIHL) were identified in questionnaire inquiry. Data on sound pressure levels produced by various groups of instruments were also collected and analyzed. Measured hearing threshold levels (HTLs) were compared with the theoretical predictions calculated according to ISO 1999 (1990).

Musicians were exposed to excessive sound at weekly noise exposure levels of for 81–100 dB (mean: 86.6±4.0 dB) for 5–48 years (mean: 24.0±10.7 years). Most of them (95%) had hearing corresponds to grade 0 of hearing impairment (mean hearing threshold level at 500, 1000, 2000 and 4000 Hz lower than 25 dB). However, high frequency notched audiograms typical for noise-induced hearing loss were found in 35% of cases. Simultaneously, about 35% of audiograms showed typical for NIHL high frequency notches (mainly occurring at 6000 Hz). When analyzing the impact of age, gender and noise exposure on hearing test results both PTA and TEOAE consistently showed better hearing in females vs. males, younger vs. older musicians. But higher exposure to orchestral noise was not associated with poorer hearing tests results.

The musician's audiometric hearing threshold levels were poorer than equivalent non-noise-exposed population and better (at 3000 and 4000 Hz) than expected for noise-exposed population according to ISO 1999 (1990). Thus, music impairs hearing of orchestral musicians, but less than expected from noise exposure.

Keywords: orchestral musicians, exposure to orchestral noise, hearing, risk of noise-induced hearing loss.

* * *

Comparative Study of the Effects of Occupational Exposure to Infrasound and Low Frequency Noise with Those of Audible Noise

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Long-term effects of moderate levels generated in working environment are very scarce. The study aimed to compare effects

of occupational exposure to low frequency noise (LFN) in comparison with those of audible noise (AN). Three groups of 309 workers (I – exposed to LFN, II – exposed to audible noise and III – controls) were examined. Questionnaire, Blood pressure, subjective and objective hearing tests (conventional audiometry, impedance audiometry, TEOAEs, BERA), posturography, and biochemical parameters were performed for each subject. Levels of exposure in dB-A, dB-C, dB-G, octave analysis were determined.

Daily noise dose of LFN was three times higher in comparison with those of audible noise. More than 80% of energy was cumulated in 2–500 Hz range of octaves. In case of audible noise more than 75% of energy was cumulated in middle and high frequency range. Blood pressure and other biochemical parameters were worse in AN group. LFN group assessed its exposure as irritating and annoying and AN group as tiring and disturbing to hear. All parameters of hearing were worse in AN group in comparison with LFN one in whole range of frequency. The same trends were found in posturography. Contrary to results of Bourdane test. They were worse in LFN group.

The results of the study showed that audible noise is more hazardous than LFN, but LFN annoyed more. The results did not support thesis on vibroacoustic disease.

The study was funded by the National Center of Research and Development project II.B.09.

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Room Sound Field Analysis Using Integrated Multichannel Measurement System

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A number of research or diagnostic problems of the vibroacoustics puts requirements for many synchronous acquisition of measurement data resulting from the distribution of sound field parameters studied objects around or inside, in the investigated objects. The authors have built an integrated multichannel measuring system that allows synchronous recording of acoustic signals. Analysis of the sound field was performed from data recorded by microphone line in order to extract some information about the parameters of the sound field in the room. The results were processed further calculations, can be used to visualize the distribution of sound pressure in an enclosed area.

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Urban Noise Annoyance Between 2001 and 2013 – Study in a Romanian City

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The paper presents results of three socio-acoustical surveys conducted in an interval of twelve years, between 2001 and 2013, in a large Romanian city, Cluj-Napoca. The purpose of the surveys was to assess the awareness of residents on urban noise and the extent to which the noise environment affects their everyday life, behavior and health. The surveys were conducted in 2001, 2009 and 2013. The questionnaire used in the first survey had 16 questions and it was verified prior to study through a pilot survey, being corrected and improved. For the second and the third study, the questionnaire was enriched with eight more questions, regarding essentially the description of the residential area, criteria for its selection and also awareness about the noise map of the city. The analysis of responses defines the main characteristics of the local pattern of annoyance and reaction of the urban population to the environmental noise.

Keywords: noise annoyance, urban noise, socio-acoustic survey.

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The Calculation Model for Predicting Unknown Values of Partial Indices in the Index Method for Acoustic Evaluation of Classrooms

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One of the possibilities to make a comprehensive assessment of the acoustic quality of classrooms is the index method. It involves the determination of global index based on partial indices, which take into account in assessing the speech comprehension, external noise (including background noise during classes), voice effort of teachers and the comfort of teaching and learning. Due to the complexity and cost of measurement instrumentation it is a difficult task to take into account in assessment all the parameters of the index method. For this reason, it was necessary to develop methods for assessing the classroom acoustic quality at incomplete information. The paper presents calculation model based on the use of the most informative singular values taken from SVD (Singular Value Decomposition) decomposition and Repeated Matrix Reconstruction algorithm. Relative prediction errors of global indices do not exceed 4.7% for individual rooms. The developed calculation model was compared with the regression model. The simulation results show more accurate prediction using the presented calculation model.

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Aircraft Noise Evaluation Criteria for Determining Airborne Sound Insulation of External Walls of Buildings

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The paper presents the results of research carried out in connection with the revision of standard PN-B-02151-3:1999 “Building acoustics. Protection against noise in buildings”, in its part devoted to the way of determining the required sound insulation of the external walls against aircraft noise. A survey of the standards effective in selected European countries, the legal acts and regulations being in force in the EU and the state of knowledge concerning the adverse effects of night-time aircraft noise was carried out. The results of all the studies indicate a need for the use of a complementary noise index such as maximum noise level L_{Amax} . The recommended values of L_{Amax} can be found in the WHO reports. The permissible number of aircraft events with permissible L_{Amax} remains an open question.

In order to determine the domestic conditions the data from the noise monitoring at two domestic airports were analyzed. The aim of the analysis was to determine the relationship between aircraft noise events parameters L_{AE} and L_{Amax} , as well as the range of the values.

* * *

Localization of Areas of Increased Vibroactivity by Means of the Inverse Method

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The paper consists of study results of exposure to high frequency noise at metalworking workplaces. The study was carried out using objective methods (measurements of parameters characterizing noise) and subjective studies (questionnaire survey). Metalworking workplaces were located in a steel structure (e.g. deck gratings) manufacturing plant. The results of equivalent sound pressure level in 1/3 octave frequency bands with the

center frequencies from 10 kHz to 40 kHz, in reference to an 8-hour workday equal to approximately 81–105 dB on most of the tested workplaces and exceed permissible values. Questionnaire survey of annoyance high frequency noise (i.e. in the audible frequency range and low ultrasound) was conducted among 52 operators of machines. Most of the workers describe the noise as: buzzing, insistent, whistling and high-pitched squeaky. Respondents specific the noise levels occurring at workplaces as: loud, impeding communication, highly strenuous and tiring.

* * *

Diminuation of the Reverberation Time in a Multi-Purpose Hall

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The hall is part of a residential center for children and adolescents.

Although it was designed for sports, hall is also used for theater, concerts etc.

Because the architectural design not included acoustic treatments, it was necessary to further the development of measures to reduce the reverberation time.

Acoustic treatments were chosen so that their sound absorption coefficients allow obtaining more uniform reverberation time in the frequency range 125 ... 4000 Hz.

On the other hand, absorbing treatments lead to noise reduction through sound absorption.

This paper presents various solutions to reduce the reverberation time and results obtained by their application.

* * *

The Study of Behavior of Vibrating Systems Controllable by Devices with Rheological Fluid

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The nonlinear mathematical model of behavior of controllable viscosity fluid (CVF) under applied external field is presented. A large family of these fluids is commonly used to control responding forces of dampers in vibration control applications. The responding force of a damper with CVF has two components. The first one – uncontrollable – is proportional to the viscosity of a base fluid and velocity of its motion, the second one, which is controllable, depends on the strength of the applied external field. Both are involved in the process of dissipation of unwanted energy from the vibrating systems. An equivalent damping factor based on the principle of energy dissipated during one cycle of damper work under a constant strength external field was calculated. When mass or stiffness is variable the equivalent damping factor can be set accordingly by adjusting the strength of external field to have vibrating damped system purposely/continuously working in the critical or other chosen state. This paper also presents cases of applying periodically changing strengths of an external field synchronized with cycles of periodical motion of the vibrating system to continuously control the damping force within each cycle.

Keywords: noise control, vibration control, smart materials, rheological fluids.

* * *

Creating Dynamic Maps of Noise Threat Using PL-Grid Infrastructure

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The paper presents functionality and operation results of a system for creating dynamic maps of acoustic noise employing the PL-Grid infrastructure extended with a distributed sensor network. The work presented provides a demonstration of the services being prepared within the PLGrid Plus project for measuring, modeling and rendering data related to noise level distribution in city agglomerations. Specific computational environments, the so-called domain grids, are developed in the mentioned project. For particular domain grids, specialized IT solutions are prepared, i.e. software implementation and hardware (infrastructure adaptation), dedicated for particular researcher groups demands, including acoustics (the domain grid “Acoustics”). The infrastructure and the software developed can be utilized mainly for research and education purposes, however it can also help in urban planning. The engineered software is intended for creating maps of noise threat for road, railways and industrial sources. Integration of the software services with the distributed sensor network enables automatic updating noise maps for a specific time period. The unique feature of the developed software is a possibility of evaluating auditory effects which are caused by the exposure to excessive noise. The estimation of auditory effects is based on calculated noise levels in a given exposure period. The outcomes of this research study are presented in a form of the cumulative noise dose and the characteristics of the temporary threshold shift.

Keywords: noise, dynamic noise map, reverse engineering, grid computing.

* * *

Road Traffic Noise Attenuation by Vegetation Belts at Some Sites in the Tarai Region of India

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Noise measurements have been carried out at eleven different sites located in three prominent cities of the Tarai region of India to evaluate the effectiveness of vegetation belts in reducing traffic noise along the roadsides. Attenuation per doubling of distance has been computed for each site and excess attenuation at different 1/3 octave frequencies has been estimated. The average excess attenuation is found to be approximately 15 dB over the over the low frequencies (200 Hz to 500 Hz) and between 15 dB to 20 dB over high frequencies (8 kHz to 12.5 kHz). Over the critical middle frequencies (1 kHz–4 kHz), the average excess attenuation (between 10 dB–15 dB) though not as high, is still significant with a number of sites showing an excess attenuation of 15 dB or more at 1 kHz. The results indicate that sufficiently dense vegetation belts along the roadsides may prove as effective noise barriers and significant attenuation may be achieved over the critical middle frequencies (1–4 kHz).

Keywords: noise, attenuation, traffic, frequency, vegetation belt, Tarai.

* * *

Assessment of Ultrasonic Noise Hazard in Workplaces Environment

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The hazard assessment of ultrasonic noise impact on human body at workplaces presents an open problem; it is not satisfactorily solved comparing the fund of knowledge and standard regulations established for the case of audible noise. Some research carried on in the Central Institute of Labour Protection – National Research Institute, Poland, are essential for elaboration reliable procedures for the assessment of ultrasonic noise hazard and they have to bring to modernization and creation the corresponding standards in this field. In the presentation, some problems related to measurement procedures applied as well as to the interpretation of results essential for hazard assessment of ultrasonic noise impact on human body will be considered; in particular such cases where some procedures elaborated for audible noise assessment are being transferred to apply in the ultrasonic range without taking fully into account some specific aspects of the high frequency components of the noise.

Keywords: ultrasonic noise hazard assessment, maximal acoustic level values distribution, technological ultrasonic devices.

* * *

Experimental Acoustic Flow Analysis Inside a Section of an Acoustic Waveguide

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Noise propagation within ducts is of practical concern in many areas of industrial processes where a fluid has to be transported in piping systems. The paper presents experimental data and visualization of flow in the vicinity of an abrupt change in cross-section of a circular duct and on obstacles inside where the acoustic wave generates nonlinear separated flow and vortex fields.

For noise produced by flow wave of low Mach number, laminar and turbulent flows are studied using experimental sound intensity (SI) and laser particle image velocimetry (PIV) technique adopted to acoustics (A-PIV). The emphasis is put on the development and application of these methods for better understanding of noise generation inside the acoustic ducts with different cross-sections. The intensity distribution inside duct is produced by the action of the sum of modal pressures on the sum of modal particle velocities. However, acoustic field is extremely complicated because pressures in non-propagating (cut-off) modes cooperate with particle velocities in propagating modes, and *vice versa*. The discrete frequency sound is strongly influenced by the transmission of higher order modes in the duct. By understanding the mechanism of energy in the sound channels and pipes we can find the best solution to noise abatement technology.

In the paper, numerous methods of visualization illustrate the vortex flow as an acoustic velocity or sound intensity stream which can be presented graphically. Diffraction and scattering phenomena occurring inside and around the open-end of the acoustic duct are shown.

Keywords: sound intensity, laser anemometry, acoustics flow, sound visualization.

* * *

The Soundscape Design. Factors Impacting the Spatial Orientation of Blind and Visually Impaired People

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The term soundscape was proposed by R. Murray Schafer in 1977 as an auditory equivalence to landscape. It is defined as an environment of sounds – actual or abstract. In opposite

to noise control soundscape approach treats sound as a resource rather than a waste. Its main applications focuses on managing urban public spaces in order to improve quality of life. Psychoacoustic experiments on the soundscapes shows that recognition of particular environments is based on identification of the physical sources and average recognition time for humans is about 20 s. According to (DUBOIS D., GUASTAVINO C., RAIMBAULT M., *A Cognitive Approach to Urban Soundscapes*, Acta Acustica united with Acustica, **92**, 6, 865–874, 2006, semantic data must be obtained as well as numerical estimators for the development of the categorization and quality labels.

Sound acting on human body stimulates certain parts of the brain. It's usually different for different types of said stimuli (visual, acoustic, tactile, etc.). But basically thanks to EEG, PET or/and MRI it can be said that we know which part of a person's brain will "lit up". There are several studies that incorporate EEG, PET or/and MRI to compare brain functions in sighted and blind persons during different types of auditory (or tactile for that matter) tasks.

Soundscape could be connected with visual impaired people in many ways. Sounds are key in blind people's spatial orientation. Without sounds blind person feel like normally sighted person in darkness. The role of sound could be compared with turning on the light.

Schafer in *The Tuning of the World* formalized the soundscape terminology. Background sounds were defined as "keynotes", foreground sounds which intended to attract attention as "sound signals" and sounds that were particularly regarded by a community and its visitors are called "soundmarks".

The paper presented attempt of classification of the acoustic signals that can be useful for spatial orientation. This classification was made based on Shafer's division. Data from a survey carried out in group of blind and partially people were used for analysis. In survey respondents were asked about sounds that can assist or disturb the spatial orientation and for negative impact of weather conditions on the perception of sounds in an urban environment.

* * *

Controllability-Oriented Placement of Actuators for Active Noise-Vibration Control of Flexible Structures Using Memetic Algorithms

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For successful active control with a vibrating plate it is essential to appropriately place actuators. One of the most important criterion is to make the system controllable, so any control objectives can be achieved. In this paper the controllability-oriented placement of actuators is undertaken. First, a theoretical model of a fully clamped plate is obtained. Influence of actuator placement on the structure is considered. Optimization criterion based on maximization of controllability of the system is developed. Residual modes are taken into account to reduce a spillover effect. The memetic algorithm is used to find the optimal solution. Obtained results are compared with those obtained by the genetic algorithm. The configuration is also validated experimentally.

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Uncertainty of Acoustic Measurements Performed with Audio Analyzers

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For some time the users of various types of sound measurement devices and speech transmission indicators (STI and STIPA) express an increased demand for metrological testing of their devices. In a number of cases the devices are rather cheap

products that are supposed to substitute for dedicated devices that are inaccessible for the “economy-class” users, because of their price range. The calibration of such devices, conformant to the rules imposed on professional devices, is rather difficult if not impossible. In order to perform the testing properly it is necessary to elaborate individual testing methods for each device. The author of the present paper managed to elaborate a set of such methods. In the process she has used her knowledge concerning the essence of normative testing and the knowledge related to logic of functioning of these devices. She gained the experience in testing measuring devices during her long-time work in accredited calibration laboratory (AP 022).

The paper presents the basic technical, metrological and legal information, concerning the requirements imposed on sound level meters and the methods of their calibration. The paper also describes specific problems encountered during application of normalized methods to testing of audio devices. Exemplary results are also presented for calibration and testing of the following devices: ECM800 microphone by Behringer, AZ8921 meter by AZ Instrument and the NTI Audio XL2 and NTI Acoustilyzer AL1, audio and acoustic parameter analyzers by NTI Audio AG.

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Parameterization and Assessment of Curve and Brake Squeal from Train Approaching to the Station

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The most important source of noise from railways at most speeds is rolling noise caused by wheel and rail vibrations induced at the wheel/rail contact. Rolling noise is fairly broadband in nature, the relative importance of higher frequency components increasing as the train speed increases. But the curve squeal is one the loudest and most disturbing noise sources from railways metros and tramways. It is also caused by interaction between wheel and rail but has a quite different character. It is strongly tonal noise occurring in sharp curves, being associated with vibration of the wheel in one of its resonances. It is also necessary to distinguish between squeal caused by lateral creepage, top of rail squeal as well as flange squeal. A similar phenomenon is brake squeal which is emitted during braking.

When the train commute to the station the two phenomena may be a source of great inconvenience to passengers and station staff. The experimental investigations of aforementioned noise squeals were performed when the train approaching into the platform. The results show increased noise ratios up to over ten dB, in addition to a high content of the tonal components with frequencies above 5 kHz. It was shown that the spectral moments of the noise can be an useful tool in automatic identification squealing noise in continuous monitoring systems.

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Simultaneous Exposure to Hand-Arm and Whole-Body Vibration at One-Track Vehicles Drivers Workstations

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The increasing traffic contributes to a greater interests in one-track vehicles. They require much less space both on the road and parking and allow for reach places inaccessible to other vehicles. The growing number of one-track vehicles in work environment (e.g. the police, emergency medicine, courier companies) also affects the increase in the number of workers exposed to vibration hazards associated with their use. The methods of measurement and evaluation of vibration on workers described in the European standards EN 14253 and EN ISO 5349 establish separate treatment of hand-arm vibration (HAV) and whole-body vibration (WBV). However, at one-track vehicles the risk of HAV and WBV coincides.

The dose of vibroacoustic energy absorbed by the worker is greater larger when the impact of both kinds of vibration occurs simultaneously than when the worker is exposed to only one kind of vibration. The paper presents evaluation of simultaneous exposure to hand-arm and whole-body vibration for selected one-track vehicles drivers. The results show that the vibration hazards at these workstations may be significant.

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Assessment of Exposure to Excessive Sounds and Hearing Status in Students Enrolled in Academic Music Education

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The overall aim of this study was to evaluate the hearing status, exposure to excessive sounds and the risk of noise-induced hearing loss (NIHL) in college music students.

A pilot study, including questionnaire inquiry and sound pressure level (SPL) measurements, was carried out in 35 students. From these data, the risk of noise-induced hearing loss (NIHL) was assessed according to ISO 1999:1990.

It was found that college music students were exposed to excessive sounds at the A-weighted equivalent-continuous SPL of 81–99 dB for 2.5–44.0 hours per week (mean: 21.3 ± 13.8 hours per week). The highest SPLs were observed among percussion, trumpet, trombone, saxophone, horn and flute players.

Such exposures for 5 years of academic education are associated with the risk of hearing impairment (expressed as mean hearing threshold level for 2, 3 and 4 kHz equal to or greater than 25 dB) in the range of 0–46%. The highest risk is related to playing percussion section (up to 46%), saxophone (up to 16%), trumpet (up to 15%), trombone (up to 14%) and bassoon (up to 7%).

About 37% of students noticed hearing impairment, including difficulty in speech intelligibility in noisy environment (51%). Nearly every tenth of respondent complained of tinnitus, while 29% of them reported hyperacusis. Only a few students declared usage of hearing protectors, while 31% of them – listening to music via mp3. Thus, the results confirm the need of further studies and development of hearing conservation program for college student musicians.

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Low Frequency Noise and Its Assessment and Evaluation

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The main aim of this paper is to present recent knowledge about the assessment and evaluation of low frequency noise and infrasound close to the threshold of hearing and the potential effects on human health. Low frequency noise generated by air flowing over a moving car with the open window is chosen as a source of noise. The noise within the interior of the car and its effects on a driver's comfort at different velocities is analyzed. An open window at high velocity behaves as a source of specifically strong tonal low frequency noise which is annoying. The interior noise of a passenger car was measured under different conditions; while driving on normal highway and roadways. First, an octave-band analysis was used to assess the noise level and its impact on the driver's comfort. Second, a *Fast Fourier Transform* (FFT) analysis was used for the detection of tonal low frequency noise. Finally, the paper suggests possibilities for scientifically assessing and evaluating low frequency noise but not only for the presented source of the sound.

Keywords: low frequency sound, human being, health, evaluation.