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## Abstracts

### Simulation of Vibration Wave Propagation from the Rail Vehicles Subgrade to the Environment

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The problem of vibration wave propagation in the soil caused by the railway vehicles movement is extremely important from the point of view of the environment protection from the negative effects of dynamic impacts caused by rail transport. One of the methods that can be used to evaluate the dynamic impact is modelling using finite elements. The article presents a dynamic analysis of the railway subgrade structural model and the impact of applying the vibration isolation system on the amplitude level of ground vibrations caused by the vibration waves propagation from the trackway. The application of finite element method allows to analyse the behaviour of engineering structures in varying conditions of service dependent primarily on the speed of traffic on the trackway. Such an analysis involves the use of a number of individuals that can be used to assess the impact of vibration on any object engineering. Such size can include first of all the acceleration at any measuring point on a measuring section from the track to, for example, residential or industrial building. Comparing these amounts with publicly available criteria and standards allows for the design at early stage of engineering design for the necessary modifications construction of subgrades in order to reduce the amplitude of vibration transmitted to the environment. These modifications consist mainly in a suitable vibration isolation system as an example boards or mats laid in a layer of the track or washers under tracks. Such an approach to the design process is particularly important due to the inability to modify the track built after the completion of the work and because of the limitation of the duration and cost of designing.

Keywords: finite elements method; simulation studies; vibration isolation system.

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### Simulation Studies of the Dynamics of Railway Crossings with Vibration Isolation Based on Elastomeric Damping Elements

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A large technical progress in the last time, closely associated with the development of technology and industry, on the one hand contributed to the creation of many modern technologies but, on the other hand, has exacerbated phenomena pose a threat to humans and the environment. Constantly evolving at a rapid pace transport is one of the areas of industry, which has a significant share in this threat both in terms of rail (railway, tramway) as well and road transport. The constant development of the road and rail network is the inherent cause of negative interference with the natural environment. Railways and roads clearly divides the area through which they run, occupies large areas of land and, by the intensity of rail and road transport, have a negative impact on the environment as a source of vibration and noise. The broadly understood transport is accompanied by inherently dynamic effects on the environment causing mechanical vibrations of foundations, ground and engineering structures. Minimization of this harmful effects is a necessity and led to the creation of both new construction of transport equipment with reduction of the

vibroacoustic energy emissions as well as complex vibration isolation systems which limited the spread of vibrations in to the environment. Railway crossings are a one of the critical engineering structures where a significant amount of vibration energy is created and then passed into the environment and causing structural damage and negatively affects people. The paper presents examples of reducing the impact of these interactions by application of vibration isolation system in the construction of railway crossings.

Keywords: railways crossings; simulation studies; vibration isolation system.

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**Innovative Solutions of Reducing the Noise Generated by Rail Transport**

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The article presents selected, now available in rail transport acoustic 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 innovative solution for acoustic protections for railways was presented, in the form of a pivot short acoustic barrier.

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**Experimental and Computational Studies of Total Sound Absorption for Baffle Systems**

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Baffle systems are free-hanging sound absorbing panels mounted in space where is not possible to install a suspended ceiling. The relevant issue in this paper concerns the selection of geometric parameters of the baffle systems used for acoustic treatment in, inter alia, public and industrial buildings. For this purpose, computer simulations based on finite element method (FEM) and model reverberation chamber measurements were conducted. Empirically verified values of the random incidence absorption coefficient allowed to find the relation between the sound absorption coefficients and different distances or inclinations between elements of the spatial structure. Formulated conclusions indicate the way how to select a construction of spatial panels for a pre-established function.

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**Sensitivity Analysis of the Estimation of Single-Number Sound Absorption Evaluation Index DL$\alpha$**

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Acoustic barriers are assigned to relevant classes of absorbing properties on the basis of the single-number sound absorption evaluation index assessment. Classes of absorbing properties are essential in selecting acoustic screens for the given location. The determination of the single-number sound absorption evaluation index is realised by means of measuring the sound absorption coefficient of the analysed acoustic barrier sample in the reverberation chamber.

The sensitivity analysis of determining the single-number sound absorption evaluation index was performed in the hereby paper. The sensitivity of this index to the uncertainty of determining the characteristic of the sound absorption coefficient was investigated. This characteristic is related, among others, to the measuring accuracy of the tested sample surface and to the method of correction of the reverberated sound absorption coefficients into value 1.

In order to carry out the correct sensitivity analysis of the tested model the empirical probability distributions of absorption coefficients were determined on the bases of multiple measurements of various samples of the same type, in the reverberation chamber. The influence of the accuracy of measurements of the tested sample surface as well as the influence of the sample assembling method in the reverberation chamber on the estimation uncertainty of the sound absorption coefficient for individual frequency bands, was investigated.

The Monte Carlo method, which allowed to determine variability intervals of the absorption coefficient in frequency bands, was applied for the determination of the empirical probability distributions. These intervals were used in estimating the sensitivity of the model of the single-number sound absorption evaluation index for individual input parameters. The sensitivity estimation was performed with an application of the reduction interval analysis.

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**A New Research Methodology for Assessment of Ground Vibrations Caused by the Railway Vehicles Movement**

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Nowadays, the industrial and residential buildings are located near various roads and railway lines. Therefore, in

the process of their designing one must take into account the adverse effect from the dynamic impact of transport. These interactions can lead to worsen of reliability of the equipment installed in the plant, can have a negative impact on the quality of workers work and can have negative effects and life conditions of people. Therefore, there is a need for assessment of the vibration wave propagation in the substrate well as evaluation of its negative effect on the newly designed building structure or life conditions of people. A new methodology for assessing the ground vibrations caused by the movement of rail vehicles is presented in the paper. A description of the results of experimental studies and assessment of the risks associated with the operation of rail vehicles on the road and tram crossing is also presented. The proposed method of assessing risks is based on the time-frequency analysis of signals and the estimation of a histogram of the distribution of amplitude signals.

Keywords: ground vibrations; ground vibration assessment methodology; tram transport.

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**The New Methodology for Assessing of the Applicability of Elastomeric Materials in the Vibration Isolation Systems of Railway Lines**

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The technical requirements for the determination of physical parameters of vibration isolating material has not been standardized in Europe and Poland yet, which significantly hinders the ability to compare among themselves offered on the market vibration isolating materials. Therefore, there is need to establish a norm that could be apply both for the determination of the physico-mechanical properties of elastic vibration isolation elements in rail transport for domestic and foreign producers as well as in their selection for application in a specific vibration isolation system. The paper presents a proposal to standardize the methodology of the estimation of vibration isolation materials physical parameters authorized for use in vibration isolation systems used in rail transport. Methodology for measuring the physico-mechanical parameters of vibration isolating material presented in the paper forms a uniform test procedure developed based on a fragmentary norms for flexible materials testing. The use of the proposed research methodology enables the creation of a unified database of elastic materials whose parameters will be easy to compare, and their choice will become easier for designers of vibration isolation systems used in rail transport.

Keywords: ground vibrations; ground vibration assessment methodology; tram transport.

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**Analysis of the Possibility of Limiting the Impact of Ground Vibrations Caused During Demolition of a Towers on Environment**

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During disassemble and the demolition of five granulation towers the authors planned and carried out measurements of the intensity of vibrations induced during the fall of the dismantled components towers on the ground. The main aim of the study was to determine the maximum permissible weight of falling elements of the tower during the demolition, in terms of ensuring the protection of buildings and equipment located in the vicinity of the works. Unacceptable was to increase the vibration amplitude displacement in each section of measurement on each of the three perpendicular axes by more than 2 μm peak-to-peak value and the absolute velocity of RMS of vibration amplitude cannot be increase by more than 1 mm/sec. value than a background vibration during the demolition of the towers. Preliminary experimental studies were conducted on a test stand and then authors made the measurements on the real object. As the falling elements from a height of $h = 40$ m authors was used masses 10, 40, 75 and 100 kg which were hitting the substrate without protective layer and with two types of the insulating layer. The amplitudes of vibration waves displacement and velocity were recorded on the measurement section in the direction of the protected building. The results of measurements were used to identify the propagation of the shock wave and the effectiveness of the proposed insulation layers.

Keywords: ground vibrations; insulation layers; vibrations measurements.

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**Social Conflicts and Soundscape**

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Civilisational changes have led to the fast disappearance of tranquil areas and traditional soundscapes. More and more often, the public appreciates noise hazards not only in urban areas but also in open countryside. The number of residents' complaints against noise nuisance and of social conflicts related to noise emission is growing. The main study objective was to outline the social conflicts in Poland related to the sonic quality of landscape. An analysis of Internet and press sources from the last seven years shows that sound in landscape has been a source of more than 100 social conflicts which were most frequently related to unpleasant sounds (noise nuisance) and the right to peace and quiet. These conflicts mainly occur in big

cities (e.g. Warsaw, Poznań, Katowice, Lublin), but also in towns and villages as well as tourist localities and regions, often situated within the boundaries or adjacent to protected areas (e.g. Masurian Lake District). They typically involve the residents (groups of residents), the authorities, an investor, sometimes also tourists. Sound has not always been the main cause of the disputes; sometimes it has accompanied other root causes and has been brought up as an argument for or against a specific course of action. The public demands acoustic comfort, one of the determinants of the quality of life. Therefore, it is necessary to know the public opinion on soundscapes (survey of preferences). Public consultations concerning the assessment of acoustic disturbance and sound preferences will make it possible to avoid social conflicts arising from insufficient knowledge. A major role is also played by the education of the public and decision-makers through sound awareness campaigns, e.g. as part of ecology education. Soundscape should be an object of management, defined as well-though-out, ordered and efficient action aimed at preserving and multiplying the values of soundscapes. The efficacy of management depends on the knowledge and skills of professions as well as the participation of the public in the shaping of soundscapes.

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**Detection of woodworms' larvae based on the acoustic signal analysis and the artificial intelligence algorithm**

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The paper presents an application of signal processing and computational intelligence methods to detect presence of the woodworms larvae in the wooden constructions (such as the furniture of buildings). The woodworms are one of the main sources of the degradation in such objects, therefore they should be detected as quickly as possible, before inflicting serious damage. To avoid unnecessary degradation of the construction, only the non-invasive methods of analysis are acceptable. The presented work involved the acoustic monitoring detecting the presence of the larvae inside pieces of wood. An accelerometer was used to record the sound, further analyzed by a computer algorithm extracting features important for artificial-intelligence based classification employed to detect the woodworm activity. The presented task is difficult, as the sounds made by the larvae are of relatively low amplitude and the background noise caused by people, electrical appliances or other sources may significantly degrade the accuracy of detection. The classification of sounds is needed to separate out sources of noise which deteriorate the proper larva detection and should be suppressed if possible. The employed classification was based on features defined in the time domain followed by the support vector machine used as the binary classifier. The results allowed us to assess the effectiveness of woodworm detection by the acoustic analysis enhanced with the artificial intelligence algorithm.

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**Vibroacoustic Measurements and Simulation for External Gear Pumps. An Integrated Simplified Approach**

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This paper describes the development phases of a numerical-experimental integrated approach aimed at obtaining sufficiently accurate predictions of the noise field emitted by an external gear pump by means of few vibration measurements on its casing. Harmonic response methods and vibroacoustic analyses were considered as the main tools of this methodology. FFT acceleration spectra were experimentally acquired only in a few positions of a 8.5 cc/rev external gear pump casing for some working conditions and considered as external excitation boundary conditions to a FE quite simplified vibroacoustic model. The noise field emitted was computed considering the pump something like a 'black box', without taking into account the complex dynamics of gear tooth meshing process and consequent fluid pressure/load distribution. Sound power tests, based on sound intensity measurements, as well as sound pressure measurements in some positions around the pump casing were performed for validation purposes. The comparisons between numerical and experimental results confirmed the potentiality of this approach in offering a good compromise between noise prediction accuracy and reduction of experimental and modelling requirements.

Keywords: airborne noise; gear pump; vibroacoustic modelling.

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**The Use of the Microphone Arrays for Analysis of Noise Levels in Environment**

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The noise level at evaluation point in the environment contains contribution of each noise source in the surroundings. Determination of the contribution of the noise sources located inside industrial plant in the noise level in the environment is possible by calculations of the propagation according to ISO 9613-2 standard. The calculations are based on the sound power level and geometrical models of environment. To get all needed data for large industry plants a lot of time and money is needed. In some situation the measurement by using the microphone arrays in the evaluation point in environment gives the sufficient information to determine which machine or installation has

the main contribution in noise. It is possible to estimated noise level in environment from that source. Repeating the procedure in the additional evaluation points gives more accuracy to the localization of sources of noise. The case study for this approach was presented and discussed together with known limitations.

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**Reduction of Occupational Noise Exposure for Metalworking Workstations on the Example of Cleaning after Gravelling Using Pneumatic Hammer**

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Metalworking using hand-held electric and pneumatic tools are the cause of exceedances of permitted noise levels at the workplace. In these operations the emission of noise from the tool itself is mostly negligible in comparison to the noise generated by the contact of the tool with the workpiece. The article focuses on the metal components with the dimensions smaller than the working table. The methodology of the acoustic analysis leading to the development of the acoustic guidelines, concept, design and implementation of solutions was discussed in general. Case-study for the cleaning after gravelling using pneumatic hammer was presented. According to the author's professional experience this kind of operations causes the highest levels of noise at the workplace. The operation involves removing particles which remains inside tight strictures, tubules and cavities of the metal with a complicated structure after gravelling by hitting it with a pneumatic hammer. As so far there is no effective solution which could eliminated this operation from the technological process. Equivalent sound level during these operation is in the range from 115 to 120 dB. This operation exceeds the permissible daily noise exposure level, maximum and peak sound level. The necessary noise reduction is from 15 to 20 dB. This paper presents a prototype solution that meets these requirements, designed and built by a KFB Poland team. Conceptual design, calculations and results of acoustic measurements of effectiveness of the solution were presented.

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**Analysis of Methods of Assessing the Impact of Aviation Noise Used in Poland**

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Each airport used in Poland is obliged to draw up the environmental impact of aviation noise reports recurring on the environment. This is related to the possibility of the normal operation of the airport. Take-offs and landings of aircraft always cause the deterioration of the climate parameters around sound airport or helicopter airfield. In most cases, the negative effects of noise goes beyond the boundaries of the ownership of the site intended for airlines. Consequently, around many Polish airports laid down the areas of limited use. In the course of the standard operation of the airport is estimated equivalent sound level $L_{Aeq}$ for each day and each night are subject to assessment at the same time $n$. $L_{Aeq}$ long-term indicators sound level $L_{DWN}$ and $L_N$ from the period around the year. Airports operating continuous noise monitoring is also available from any evaluation period, for example one month. Submitted to the procedures and requirements are of course impact on the assessment methods to be used.

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**Simultaneous Analysis of Vibrations and Noise in the Task of Minimizing Vibroacoustic Activity of Machines**

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Simultaneous propagation of vibrations and noise has an important role in the task of minimizing vibroacoustic hazards on the station of operator of the construction machinery. In many cases vibrations transferred by the construction are processed to noise in different points of the machine. As a result, they may increase the level of noise at the workplace. The paper presents the proposition of a simple estimation of noise and vibration propagation paths of the machine. On the basis of the analysis of hydraulic excavator there was shown an effectiveness of a proposed procedure. This procedure helps to minimize the transfer of vibrations of power unit in selected frequency ranges, which led to the change of overall noise level in operator's cab about 5 dB.

Keywords: signal separation; noise minimizing; frequency response function.

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**The Hearing Thresholds of Employees Exposed to Noise Generated by the Low-Frequency Ultrasonic Technological Equipment**

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The aim of the study was to assess the hearing status of employees exposed to noise generated by technological low-frequency ultrasonic equipment and a comparison with the hearing status of workers exposed to audible noise (without a dominant share of ultrasonic components) at similar A-weighted sound pressure level.

Ninety employees exposed to noise generated by ultrasonic devices were tested to assess the ultrasonic noise impact on hearing status (mean ± SD; age $41.4 \pm 10.0$ years, internship $17.3 \pm 9.8$ years, mean daily noise exposure level $\langle L_{EX,\,8\mathrm{h}} \rangle = 80.6 \pm 2.9$ dB). The study included: 1) measurement of ultrasonic and audible noise at workplaces,

2) hearing tests: pure tone audiometry, high-frequency audiometry and 3) the questionnaire survey on health, hearing and identification of risk factors. The exposure to audible and ultrasonic noise was assessed for all the subjects of the study group. Their hearing status was compared with the hearing status of persons occupationally exposed exclusively to audible noise at similar exposure levels (age $39.8 \pm 7.7$ years, internship $14.0 \pm 7.3$ years, $\langle L_{EX,\ 8\mathrm{h}} \rangle = 81.8 \pm 2.7$ dB).

Audiometric thresholds of hearing at a frequency of 0.5–6 kHz were similar in both groups, but in the frequency range of 8–12.5 kHz they were higher in the group of employees exposed to ultrasonic noise.

The findings suggest that differences in the threshold of hearing (at high frequencies) in analyzed groups may be due to differences in spectral composition of noise and show the need to continue the undertaken studies.

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**Using of the Energy from Mechanical Resonance**

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The paper describes the process of accumulation and extraction of the energy during mechanical resonance. During the vibration of the mechanical system, vibration amplitude depends on the ratio of the frequency of the exciting force to the natural frequency of the system. Under resonance conditions, for example in a harmonic oscillator, the frequency of the exciting force is equal to the resonant frequency of the oscillator. The vibration amplitude and total mechanical energy of the oscillating mass increase to certain value, dependent on the level of damping. At resonance in the steady state conditions, the delivered energy is equal to the energy dissipated in the oscillator. The energy stored in a harmonic oscillator at resonance, will be many times higher than the energy delivered during one cycle of vibration. The maximum vibration amplitude at resonance depends strongly on the damping occurring in the mechanical system. There are many solutions to eliminate the phenomenon of resonance in machines. To reduce the vibration amplitudes in machines under resonance conditions different dampers are typically used. There are not many information about useful application of mechanical resonance. This paper presents the results of research aimed at explaining how energy stored in the mechanical resonance can be used in machine drives.

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**Auditory Perception and Speech Communication with Hearing Protective Devices**

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Workers must be sufficiently protected from noise through engineering control, hearing protection and other methods. At the same time, they must maintain good communication abilities and awareness of important sounds from the surrounding work environment. The latter objective is difficult to achieve in several situations owing to the complex interaction between such factors as the attenuation of the hearing protectors, the acoustical characteristics of the target signal and competing noise, the hearing status and language proficiency of the workers, and the nature of the task to be performed. This presentation will provide an update on the effects of hearing protective equipment on sound detection and localization as well as speech production and perception in workplace noise. Both conventional passive hearing protectors and specialized electronic devices are treated. The latter offer some benefits for special applications or populations of workers. A particular emphasis of the presentation is on hearing protection solutions for workers with a pre-existing hearing loss.

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**3M™ E-A-Rfit™ Dual-Ear Validation System as Tool for Education in the Proper Use of Hearing Protection**

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Problems with a proper use of personal protection equipment have been known for many years. Results of the tests concerning effective protection against noise provided by hearing protection devices have shown that "real-world" attenuation is sometimes over a dozen dB lower than the declared assumed protection. The tests carried out by Central Institute for Labour Protection – NRI demonstrated that in about 53% of cases the "real-world" attenuation provided by hearing protection devices was lower than estimated based on laboratory testing. Training with fit test systems is the best way for effective education of workers who wear hearing protection devices. The researches show that the training with objective "real-world" attenuation measurements is one way to increase of awareness of the proper use of hearing protectors. In this paper the 3M™ E-A-Rfit™ Dual-Ear Validation System is presented, as a way increasing knowledge of the proper use of hearing protectors.

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**Integration of Multiple Measuring Systems Using LabVIEW Environment**

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In everyday practice, vibroacoustics uses multiple measurement systems. From simple devices with a single chan-

nel to complex multi-channel systems based on industrial computer architecture such as PXI/VXI. Due to the development of measurement techniques and the variety measurement systems creates a need to create common ground to enable cooperation between them. Users often on their own create tools for processing, compilation and presentation of results from various systems, this is the first step towards closer integration. As a next step may be to propose an object-oriented system using hardware abstraction layer. The purpose of this layer is to separate the method of obtaining the results from the method of its presentation or how to configure the measurement system. This approach reduces the use of multiple systems to a single common cohesive user interface. Other design patterns based on object-oriented programming, you can create the architecture of the system transparent to the programmer. The combination of these features provides the possibility of leaving the system open to further integration. This article is proposing such software with a description of the mechanisms and programming techniques used in the making of the prototype in LabVIEW.

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**ArAc-Multibook of Architectural Acoustics**

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ArAc-Multibook of Architectural Acoustics is a free, four-language application for personal computer and mobile devices (tablets, smartphones both for iOS and Android). The Multibook is meant to give a basic understanding of architectural acoustics to urban planning, architecture and other professionals. This interactive publication is intended to fill, in an innovative way, the gap that exists in the technical literature in this field. Arac. is the first application of this kind in the form of a acoustics manual for architects enriched with audio, image galleries, animations, instructional videos and elements of interactive infographics. The effect of collaboration between researchers and entrepreneurs is response to meet demands of modern information society and also architects who require a lot as far as quality and presentation of information are concerned. Hence, deepening, improving and broadening knowledge is transferred into the virtual reality, in which a traditional, printed book is replaced with mobile data carriers. This implies a new way of society education – "the futuristic way of education". A possibility of learning in mobile environment responds to current situation of many people. Mobile access to learning database gives them a great possibility to spend potentially non-productive time for acquiring new information and skills.

The Multibook is used as an independent educational tool, systematising the knowledge on architectural acoustics, introduction to the acoustic issues and the continued assistance in designing. This project has been funded with support from the European Commission under the Lifelong Learning Programme.

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**Simulation of Acoustic Load on the Filter of the Wide Field Instrument of the Athena Space Mission During Launch**

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ATHENA is an X-ray observatory-class space mission selected by the European Space Agency for L2 – the second Large-class mission within the Cosmic Vision science program scheduled for launch in 2028. One of the key instruments of ATHENA is the Wide Field Imager (WFI) which will provide imaging in the 0.1–15 keV band over a $40'$ diameter field of view, together with spectrally and time-resolved photon counting. For proper measurements of the instrument, the use of an X-ray transparent optical blocking filter is needed to allow the observation of all type of X-ray sources that present a UV/Visible bright counterpart. The thickness of the filter is around 200 nm. The filter is placed in the Filter Wheel (FW) part of Filter Wheel Assembly. Technical challenges for the FW mechanical structure besides the proper functionality are also connected with the protection of the optical blocking filter. Mechanical structure of the FWA should allow to applied the elements made of damping material (load absorber) or technical solutions to obtain possible small mechanical loads in the plane of the filter mount. Moreover the proposed design of the FWA should allow to minimize acoustic loads during launch phase for the optical filter protection. FWA structure during launch will be loaded by combination of the random vibration and acoustic excitation. Combination of these load and complexity of the phenomenon, make the computer FEM simulation difficult because of the difficulties in proper analysis model choosing. The acoustic loads are difficult to suppress and they can have significant influence on design of the FWA. From this reason the acoustic loads are primary target for analysis. Results of analysis are present in the paper.

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**Modern Methods for Analysis of Non-Linear Vibration Illustrated by the Case of Low-Power Facilities**

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The article presents the results of dynamical analysis of a rotor – bearings system in micro-turbines with the capacities from several kW to tens of kW. Such low power capacities are typical for micro-sources based on the so-called ORC cycles, that is, installations using low-boiling fluids as working mediums. Micro-turbines in this power

category are key components of cogeneration or polygeneration systems, in other words: installations producing heat and electricity (and also cold) for the needs of individual or municipal customers. Unfortunately, the exploitation of facilities of this type sometimes leads to problems related to maintaining stable operation of a rotor and bearings, not only because it generates noise but also because it can cause the efficiency of a whole system begins to deteriorate significantly. The paper shows the ways to avoid these undesirable phenomena or at least minimize their impact on operating machines.

Low-power cogeneration units are the very essence of the prosumer power engineering, sometimes referred to as civic power engineering, in which the citizen is both a consumer and a producer of energy. It is a beautiful vision that fully corresponds to the modern trends of power development. This article also provides some broad reflections on development opportunities for civic power engineering in Poland.

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**Perception of Changes in Timbre and Envelope of Musical Signals vs. hearing fatigue**

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The paper presents results of research on an influence of hearing fatigue on the detection of changes in timbre and envelope of musical samples. The experiment was carried out under conditions which normally exist in a studio when sound material is recorded and mixed. The level of sound exposure is usually 90 dB and this is an average value of sound level existing in control room at various recording activities. This musical material may be treated as an unwanted noise so Temporary Threshold Shift phenomenon may occur after several time durations and this leads to a listening fatigue effect. Fourteen subjects participated in the first part of the experiment and all of them have the normal hearing thresholds. The stimuli contained the musical material with introduced changes in timbre up to +/−6 dB in low (100 Hz), middle (1 kHz) and high frequency (10 kHz) octave bands. In the second part of research five subjects listened to the test containing musical samples with introduced envelope changes up to +/−6 dB in interval of 1.5 s. The time of loud music exposure was 60, 90 and 120 minutes and this material was completely different than the tested samples. It turned out that listening to the music with an exposure of 90 dB for 1 hour influences the hearing thresholds for middle frequency region (about 1–2 kHz) and this has been reflected in a perception of timbre changes: after 1 hour listening the changes of spectrum in middle-frequencies region are perceived with a threshold of 3 dB while the changes of low and high ranges of spectrum were perceived with the thresholds of 1.8 and 1.5 dB, respectively. After the longer exposure, the thresholds shifted up to 3.5 dB for the all investigated stimuli. It has been also found that hearing fatigue after 1 hour of a listening influences the perception of envelope which gets worse of 2 dB in comparison to the fresh-ear listening. When the time of listening to the loud music increase the changes in envelopes which can be detected rise to the value of 6 dB after 90-minutes exposure and does not increase with further prolongation of listening activity time.

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**The Role of Accredited Testing Laboratories in Performing Surveillance of Noise and Vibration Hazards at Workplaces in Poland**

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Vibroacoustical processes exist in all areas of human activity. Of special importance results therefore the task of monitoring the influence of vibration and noise on worker's potential health risks. The experience of several generations resulted in regulations (standards or legislation) that define the threshold values for noise and vibration signals in working environment, which allows for adequate assessment of vibration and noise nuisance for a particular worker.

Laboratories, which periodically analyze the characteristics of vibroacoustic signals at workplaces, play an important role in monitoring the hazards. According to current regulations, accreditation is a compulsory form of confirming competence of such laboratories. In accordance with international agreements, there are national accreditation bodies established for the purpose of accreditation of conformity assessment system of goods and services: in Poland it is the Polish Centre for Accreditation

In Poland there are over a thousand accredited laboratories, of which over three hundred specialize in investigating parameters of vibroacoustical process affecting humans at the workplace. Standardized tests are carried out according to the established procedures; the results are reproducible and comparable thanks to measurement traceability and implemented management systems. The results of tests performed by these laboratories are binding both for the employers and the institutions supervising working conditions; they permit reducing the risk of vibration or noise affecting workers, and sometimes can be used to enforce application of procedures leading to minimizing noise or vibrations affecting humans in their work environment.

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**Calibration of Vibration Measuring Equipment in the Low Frequency Range in GUM (Central Office of Measures)**

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The paper presents the method of calibration and metrological characteristics of primary low frequency vibration standard developed in GUM. With the rise of industrialization, introduction of new technologies, faster and

faster vehicles mechanical vibrations become a part of our environment and are an increasingly important element of danger. They constitute the harmful factor acting on a human being and on all devices in human's environment. The need to evaluate these impacts requires performing precise vibration measurements. This goal can be achieved, among others, through the calibration of the instruments for the measuring of mechanical vibrations. GUM, as the institution with the best measurement capabilities in Poland, is the source of traceability for the calibration and testing laboratories in Poland. In vibration domain this role is fulfilled by Acoustics and Vibration Laboratory with the primary standard of vibration quantities. To 2013 Laboratory was able to perform absolute calibration of vibration instruments (mainly accelerometers) according to ISO 16063-11 in the frequency range from 10 Hz to 10 kHz. Taking into account that calibration in low frequency range is recently of more importance Acoustics and Vibration Laboratory of GUM has taken the considerable effort to develop the measurement set-up with wider frequency range of calibration. New measurement set-up allows to perform primary calibration of vibration transducers in the frequency range of 0.4–63 Hz with the relative uncertainty of equal or less than 0.5% and in the range of 0.2–0.4 Hz with the relative uncertainty of not more than 1.0%.

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**Noise Hazard in the Polish Coal Mining**

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In Poland in 2014, 184 300 people were working in conditions connected with noise. That was 54.3% of general number of people employed in hazardous working environment. The biggest number of people employed in noise hazard conditions in Polish economy sectors was recorded in coal mines and manufacturing. In 2014 the factor of occupational diseases morbidity in Polish mining industry was several times higher than in other Polish economy sectors and was 296 out of 100 000 employees.

The authors of the article analyze the size of noise hazard in Polish mining industry and KWK "Bobrek – Piekary" in the aspect of occupational hearing loss and the number of workers employed in hazardous working environment. The authors of the article also suggested the alternative method of noise reduction at conveyor belt working places by constructing technological niches and their acoustic adaptation. The obtained results, conducted before and after the introduction of suggested solution, prove its efficiency. Such solution allows to reduce the risk of occupational hearing loss connected with the noise occurring at conveyor belt working places underground improves comfort and safety of work.

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**Impact of Filtration of Random Mechanical Disturbance in Noise Dosimetry on Result Uncertainty of Noise Hazard Assessment**

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Disturbance during the noise dosimetry measurements in the environment often generates so-called gross errors. Such disturbance can be caused by many factors, frequently by mechanical action on the measuring instrument. In case of continuous measurements, such disturbance significantly increases the equivalent sound pressure level. This type of disturbance in dosimetry measurements considerably reduces the accuracy and increases the measurement uncertainty.

Actual sound signals, continuously monitored during an eight-hour shift according to the noise dosimetry requirements, were used to analyse the possibility of filtration of such disturbance. The variations of the A-weighted equivalent sound pressure level in the chief borer's workplace were recorded in order to assess the occupational hazard. The instances when the allowed exposure level was exceeded were analysed, in relation to both the eight-hour shift and the A-weighted maximum sound pressure level. These results were used as an input to assess the impact of the chosen filtration method on the uncertainty of the conducted examinations.

During the analysis of variation of the A-weighted equivalent sound pressure level over time, the sequences of acoustic events related to the simulated mechanical action on the measuring instruments were randomly rejected. Then, an analysis was conducted to determine the impact of the number of rejected events on the uncertainty of determination of the equivalent sound pressure level. The impact of the rejected event's duration on the measurement uncertainty was also assessed. The Monte Carlo method was used to assess the impact of this method of reduction of the examined disturbance on the uncertainty of determination of the equivalent sound pressure level and of the exposure level.

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**Loudness Scaling Test Based on Categorical Perception**

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The main goal of this research study is focused on creating a method for loudness scaling based on categorical

perception. Its main features, such as way of testing, calibration procedure for securing reliable results, employing natural test stimuli, etc., are described in the paper and assessed against a procedure that uses 1/2-octave bands of noise (LGOB) for loudness growth estimation. The Mann-Whitney U-test is employed to check whether the proposed method is statistically equivalent to LGOB. It is shown that loudness functions obtained in both methods are similar. Moreover, the band-filtered musical instrument signals are experienced as more pleasant than the narrow-band noise stimuli and the proposed test is performed in a shorter time. The method proposed may be incorporated into fitting hearing strategies or for checking individual loudness growth functions and adapting them to the comfort level settings while listening to music.

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**Why Earplugs Performance in Real World is Often Very Poor?**

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The paper presents the results of a study on factors influencing the earplugs performance in a real world. The survey was conducted in laboratory conditions and two industrial plants. Personal Attenuation Rating (PAR) of earplugs was measured with the use of a VeriPro system developed by Howard Leight Honeywell Hearing Laboratory. Seven models of disposable and two models of reusable earplugs were tested. The aim of the laboratory study was to obtain mean PAR values for tested models of brand new samples when they were properly fitted in ear canals. The measurements were carried on with 16 trained subjects and 5 naive subjects who were instructed how to correctly insert earplugs in ear canals. In industrial plants, earplugs were tested with the participation of 152 workers, who inserted the earplugs as they do it usually on every working day. The general conclusion was that the main factor causing poor performance of earplugs was incorrect fitting of earplugs in ear canals (wrong selection or incorrect inserting in the ear canal) and bad technical condition of worn reusable earplugs. The largest measured decrease in PAR values for earplugs worn in a real world exceeded by 27 dB PAR values for brand new samples measured in the laboratory with trained subjects.

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**3D Acoustic Field Intensity Probe Design and Measurements**

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The aim of this paper is two-fold. First of all, some basic notions on acoustic field intensity and its measurement are shortly recalled. Then, the equipment and the measurement procedure used in the sound intensity in the performed research study are described. The second goal is to present details of the design of the engineered 3D intensity probe, as well as algorithms developed and applied. Results of the intensity probe measurements along with the calibration procedure are then contained and discussed. Comparison between the engineered and the reference commercial probe confirm that the designed construction is applicable to sound field intensity measurements with a sufficient effectiveness.

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**Test Bench for Research of Whole-Body Vibration Influence on Some Physiological and Psychomotor Functions of Employees**

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This paper presents the test bench designed for research on the effects of low frequency vibration on the musculoskeletal system and psychomotor functions of employees. The main part of the bench is the system for simulation of exposure to whole-body vibration. The system is based on vibration exciter made by IMV and a developed test seat, which is a structure comprising a mounting system and equipment in the form of the steering wheel and pedals set of vehicles. The test seat ensures during the test the correct position of the subject of 160–190 cm height. In order to provide increased strength and rigidity the seat attachment system have been developed in the form of a welded cage structure. The scope of research using the test bench include study of parameters of blood circulation and muscle tension in specific areas of the body as well as tests of psychomotor and cognitive function.

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**Noise in Sea Environment**

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Hydrosphere, like atmosphere, is a fluid environment where elastic waves propagate. If a certain spectral range of waves propagating in these environments is specified,

bands corresponding to the acoustic waves can be distinguished. While analyzing the acoustic waves propagating in the water, it can be stated that there is a certain spectral area, which directly corresponds to the range of hearing of marine animals. Aside from the complex structure of underwater disturbances, one can easily extract such area, called also the underwater noise, that is connected with generally understood human activity.

In the paper, the main emphasis will be put on the dominating source of noise which is the noise produced by means of both surface and underwater transport, i.e. shipping noise. Moreover, the attention will be paid to the increasingly widespread source of noise associated with the development of so called wind farms in the marine areas. The impact of tracking systems, that became more widely used by both military and civilian ships, has also a great influence on the behavior of marine animals. This is unfortunately a negative influence.

From some time, the attention is gradually being drawn to the devastation of the water environment, caused by actually unlimited energy contained in the elastic waves. Only the military applications have used the stealth technology for longer time. Whereas, the information is scarce about the noise generated by the transport ships. In the field of underwater noise control, the European Union has made some steps of a legislative and metrological character.

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**Measurement of Earmuffs Attenuation at High Audible Frequencies**

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Standardised measurements of sound attenuation of hearing protectors are performed in the frequency range from 125 Hz to 8 kHz. However, noise present at many workplaces contains significant components at higher audible frequency. Therefore, the knowledge about noise attenuation with earmuffs in the audible frequency range above 8 kHz is also necessary for proper hearing protection. The aim of this study was to obtain values of the noise attenuation with 27 commonly-used earmuffs models in the one-third octave bands of 10, 12.5 and 16 kHz. Measurements were conducted with real ear at threshold (REAT) method with participation of subjects. Study showed that attenuation of earmuffs ranged from 24.7 to 42.8 dB, depending on model of earmuffs and frequency band. Furthermore, the measurements were performed with the use of artificial test fixture which is designed especially for testing of hearing protectors. Results obtained with the use of artificial test fixture indicated that this measurement method can lead to values close to attenuation measured with participation of subjects. On the other hand, values obtained with the use of artificial test fixture may differ up to 14 dB from REAT method.

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**The Importance of Testing of Hearing Protectors in Real World – a Review of Issues**

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The paper discuses the circumstances where it is aprioriate to frequently test the performance of hearing protectors. Selected human factors, occupatonal environment parameters and the methods of hearing protector performance evaluation are presented. The aim of the research is identification of mutual influence of these factor with respect to proper protection of hearing.

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**Round-Robin Adaptation Scheduling in Multichannel Active Structural Acoustic Control – Example Application for a Glass Panel**

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The paper presents an investigation of SIMO feedforward active control of glass panel vibration using multilayer neural network with partially updated weights using Round-Robin (RR) scheduling algorithm. The glass panel is controlled by three DML transducers, single microphone is used to provide error signal. Two schemes of RR algorithm are investigated: neuron based and output based. Resented investigation reveals significant computational complexity reduction by using RR adaptation while preserving high control performance.

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**The LD, LN, LDEN Long-Term Noise Level Descriptors Distribution Analysis as a Function of Measurement Point Characteristics**

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According to Polish Environment Protection Low the LD, LN, LDEN noise level descriptors are used for environmental acoustic climate evaluation as well as investigation of its changes. They are defined as annual mean values calculated for 365-day period. Results for noise level measurements are often not available for every day in the year.

The purpose of the study was analysis of traffic noise measurement results performed within the long time period. The noise monitoring stations are placed in selected points with different type of traffic: a transit road with big traffic, a city square with crossing point of two national roads, a street with neighborhood of an industrial park and house properties. The noise levels were measured 24 hours per day within few years. The values of the LD, LN, LDEN noise level descriptors were calculated for each day of the measurement period. Distribution parameters analysis of calculated values as a function of surrounding characteristics for each selected point was made. Conclusions from the analysis will be used as basis for preparation of reliable procedure concerning representative measurements point location selection and measurements time determination for traffic noise measurements. The procedure should contain accurate calculations of the LD, LN, LDEN noise level descriptors for incomplete set of measurements days.

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**Influence of the Sound Masking on the Feeling of Annoyance for Impulsive Signals**

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The aim of the paper was to investigate the common examples of impulsive noise sources generated in the free field and an attempt to determine an objective criterion for assessing the level of background noise, at which the impulsive sounds are no longer a major source of acoustic nuisance.

To this end, several signals, which are an example of impulsive sounds: a balloon, a gun and the impact of metal on metal were recorded in an anechoic chamber. For the registered signals, acoustic parameters, statistical and selected impulsiveness descriptors were calculated.

The analysis was complemented by the results of the listening tests, consisting of subjective assessment of sound annoyance and assessing the effectiveness of the masking the impulsive signals with a few examples of the noise. This research is an attempt to determine at what impulse to noise difference, the impulsive sounds no longer stand out against the background of environmental noise and cease to be characterized by high annoyance.

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**Nonlinear Structural Acoustic Control with Shunt Circuit Governed by a Soft-Computing Algorithm**

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Noise control has gained a lot of attention recently. However, presence of nonlinearities in signal paths for some applications can cause significant difficulties in the operation of control algorithms. In particular, this problem is common in structural noise control, which uses a piezoelectric shunt circuit. Not only vibrating structures may exhibit nonlinear characteristics, but also piezoelectric actuators. In this paper, active device casing is addressed. The objective is to minimize the noise coming out of the casing, by controlling vibration of its walls. The shunt technology is applied. The proposed control algorithm is based on algorithms from a group of soft computing. It is verified by means of simulations using data acquired from a real object.

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**Modern Technologies in Design, Construction and Maintenance of Railway Turnouts with Under Sleepers Pads**

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The paper is devoted to the possibility of application of pads on the underside of switch sleepers. The study contains the guidelines for application of vibroinsulation on the underside of prestressed concrete switch sleepers on railway lines in Germany and Austria. The paper presents preliminary results of analysis of the influence of vibroinsulation in prestressed concrete switch sleepers on railway switch.

Keywords: railway switch; vibroinsulation; USP.

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**The New Personal Protective Equipment (EU) Regulation 2016/425**

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The European PPE (Personal Protective Equipment) Directive 89/686/EEC (Council Directive of 21 December 1989 on the approximation of the laws of the Member States relating to personal protective equipment) was one of the first New Approach Directives and is now over 25 years old. In order to reflect current technologies and processes for developing and bringing PPE to the market, it is in the process of being superseded by the new PPE Regulation (EU) 2016/425 (Regulation of the European Parliament and of the Council of 9 March 2016 on personal protective equipment and repealing Council Directive 89/686/EEC). The Regulation text has been adopted on the 12th of February 2016 and has been published on 31 March 2016. It will come into force on 21 April 2016.

The PPE Regulation is mandatory – covering any type of product that falls within its scope including hearing protectors and anti-vibration gloves. A European Regulation is a binding legislative act, and it must be applied in its entirety across the EU without the need for separate na-

tional legislation. It will upgrade hearing protection from category II PPE to category III PPE.

Previously the PPE Directive focused on manufacturers placing products onto the market. But when the Regulation comes into force, importers, distributors or anyone involved in the supply and distribution chain have to take appropriate measures to ensure that PPE they make available on the market comply with the Regulation.

Testing and certification of PPE required by Directive 89/686/EEC for category II and III PPE is carried out by independent so called Notified Bodies. The new regulation will introduce stricter requirements not only for the "economic operators" in the supply chain but for the Notified Bodies as well.

The background of the regulation in the field of design, production, supply, selection, use, testing, certification, standardisation and market surveillance of PPE and its improvements and changes by the Regulation 2016/425 will be presented. Especially for hearing protectors an improved stability of quality level of products in the market could be expected after the Regulation 2016/425 will have been applied.

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**The Environment and Ecological Acoustic. The Current State and Perspectives**

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Paper presents the current state and prospects for the development of a dedicated and integral research trends what is the environment and ecological acoustics. This trend formed after World War II, following the development of an electronic apparatus which permits determination of the measuring volume describing waves and acoustic fields. The beginnings of the development of this trend is the work acoustics environment, binding on the impact of the noise of the environment with the reaction of the body exposition. Subsequently, account has been taken of the external influences the human environment, as a component of the overall balance of exposure. Concentration studies on external environment noises, causes the emergence of new areas of research covered by the notion of research environmental acoustics (acoustic landscapes). In the final part of the paper was that, the concentration in field of environmental acoustics caused in many countries significant stopping progress in work environment acoustics, which continuously to be a source of economic losses.

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**The Use of Mobile Devices as Tools to Support the Assessment of Exposure to Noise and Vibration**

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Technological development of mobile devices has meant that not only laptops and tablets, but also smartphones have sufficient computing power to handle even the most demanding programs. One of the new important fields of application of mobile devices is to support the assessment of the harmful effects of environmental factors on workers. Mobile devices after installing the appropriate software can be very helpful due to their size, so they can be used directly at the workplace. Large number of models of mobile devices is a significant advantage when it comes to their widespread occurrence. At the same time it involves the problem of software compatibility. Manufacturers of mobile devices adapt them to different operating systems which are intentionally modified in such a way that only programs associated with the requirements of a particular manufacturer can be run. Fortunately, there is a common development platform that allows to offer programs that can be used by the users of mobile devices irrespective of their type. These are web browsers. The article presents an analysis of the possibilities of using the universal development tools with web browsers to support assessment of the working environment. The analysis was illustrated on the example of three programs intended for the assessment of noise, hand-arm and whole body vibration. The software is compatible with the popular web browsers and can be run on mobile devices regardless of the operating system. The programs were made available on the discussion board dedicated to safety at work and have been positively reviewed by practitioners.

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**Acoustic Methods in the Rehabilitation of People who Stutter**

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Stuttering is a disorder of fluency, occurring in both children and adults. It prevents free and smooth transition from one articulation to another, and to maintain an appropriate pace, rhythm and intonation of speech. Pathological stuttering is accompanied by physiological symptoms, often combined with co-movements of the body, face, hyperactivity and spasticity. Emotionally it affects communication and social language. Inability to speak liquid leads to tension and stress of speaking. In problems of medical diagnosis, including planning and monitoring the therapy and rehabilitation of voice organs or speech-related organs, it is necessary to evaluate the qualitative features of the acoustic signal of deformed speech.

The study included 8 people who stutter: 3 women and 5 men aged 12 to 50 years, including a boy aged 12, a girl

under 14 years and other adults who themselves came to the therapy due to the lack of freedom of speech and big problems with communication. Registration time acoustic signal waveform of speech (the text read) and EGG signal was performed in an anechoic chamber Department of Mechanics and Vibroacoustics, AGH University of Science and Technology.

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**Infrasound Noise from the High Power Wind Turbines**

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The paper presents the results of the measurement and analysis of infrasound noise emitted by high power wind turbines. The presented results demonstrates the impact different conditions on the measured values, including wind speed and the type of generator. The measured levels are compared to the limit values in Poland and Europe. The paper also presented a proposal for a reference measurement methodology, which enables repetitive measurements and comparing the measured values.

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**Performance of Noise Map Service Working in Cloud Computing Environment**

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In the paper, a noise map service designated for the user interested in environmental noise is presented. Noise prediction algorithm and source model, developed for creating acoustic maps, are working in the cloud computing environment. In the study, issues related to the noise modelling of sound propagation in urban spaces are discussed with a particular focus on traffic noise. Examples of results obtained through employing a web application created for that purpose are shown. In addition, these are compared to results obtained from the commercial software simulations based on two different road noise prediction models. Moreover, the computing performance of the developed application is investigated and analyzed. In the paper, a flowchart simulating the operation of the noise web-based service is presented showing that the created application is easy to use even for people with little experience in computer technology.

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**Internal Model Control for a Light-Weight Active Noise-Reducing Casing**

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The active noise-reducing casing developed and promoted by the authors in recent publications have multiple advantages over other active noise control methods. When compared to classical solutions, it allows for obtaining global reduction of noise generated by a device enclosed in the casing. Moreover, the system does not require loudspeakers, and much smaller actuators attached to the casing walls are used instead. In turn, when compared to passive casings, the walls can be made thinner, lighter and with much better thermal transfer than sound-absorbing materials. For active noise control a feed-forward structure is usually used. However, it requires an in-advance reference signal, which can be difficult to be acquired for some applications. Fortunately, usually the dominant noise components are due to rotational operations of the enclosed device parts, and thus it is tonal and multitonal. Therefore, it can be adequately predicted and the Internal Model Control structure can be used to benefit from algorithms well developed for feedforward systems. The authors have already tested that approach for a rigid casing, where interaction of the walls was significantly reduced. In this paper the idea is further explored and applied for a light-weight casing, more frequently met in practice, where each vibrating wall of the casing influences all the other walls. The system is verified in laboratory experiments and obtained results are reported.

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**Acoustic Assessment of Open Plan Office Rooms**

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In order to assessment acoustic properties of the rooms it should compare the acoustic conditions in the room and the assessment criteria which are dependent on the purpose of the room. Open plan office rooms have specific acoustic requirements. They result from the fact that a relatively small area there are a lot of (often more than 100) workstations. The specificity of the work in these workstations is that the very often are conducted on their conversation.

Therefore, these rooms must be characterized by high acoustic absorption of the rooms and a very large decrease in speech intelligibility at a distance from the speaker. These conditions are extremely difficult to provide.

In 2012, the was designed standard EN ISO 3382-3 which determining acoustic parameters, measurement methods and limit values for rooms assessment. These parameters are: spatial decay rate of speech D2, S and A-weighted sound pressure level of speech at a distance of 4 m Lp, A, S, 4 m (both based on measurement A-weighted

sound pressure level of speech) as well as distraction distance rD and privacy distance rP (both based on measurement speech transmission index STI).

Is presented an example of the results of the acoustic assessment several open plan office rooms. Also is conducted a discussion on the possibility of obtaining a positive assessment of open plan office rooms according to the criteria specified in standard.

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**Acoustic Environment of the Upper Wildlife Crossings Over the A4 Motorway**

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The impact of transport infrastructure development on wildlife growing concern around the world. It leads to isolation of animal habitats, becoming a barrier that is hard to cross. Correct design of road network is an opportunity for sustainable development, but requires permanent and close cooperation of road builders not only with environmental protection specialists, but also with researchers dealing with air, soil and water pollution as well as those investigating the influences on the acoustic climate. In this article, the authors attempt to post – execution analysis of the acoustic climate of several wildlife crossings localized over the A4 motorway on the section Kraków – Brzesko. There are both landscape bridges as well as crossings combined with the road. Crossings were built to maintain migration corridor for many kinds of animals. The authors have been conducting measurements on the wildlife crossings of the noise generated by the road traffic in order to begin discussions concerning guidelines for design and construction of upper wildlife crossings related to noise.

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**Periodic Tests of Tympanometers: a Way to Assure Measurement Traceability and Reliability of Audiological Tests**

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Impedance audiometry includes two main tests: determination of the impedance (or admittance) of external ear canal (tympanometry) and acoustic reflex measurements. Instruments for the measurement of aural acoustic impedance, available on the market, provide tympanometry only or both tests depending on the class according to PN-EN 60645-5 standard. In Poland, tympanometry is increasingly used as a part of first audiological diagnosis, next to pure tone audiometry. Therefore there is an urgent need to assure measurement traceability and reliability of results obtained in such tests. The only way to do it is to calibrate and test the equipment for aural acoustic impedance/admittance measurements, according to PN-EN 60645-5.

In the paper the methodology and measurement setup developed at the Central Office of Measures for calibration and periodical tests of instruments for the measurement of aural acoustic impedance are presented. They are supplemented by the results of measurements and uncertainty estimation for a typical instrument being in use in Poland. The outcomes of this work will be used to develop the competence of Polish accredited laboratories in the field of impedance audiometry and let them to extend their scope of services.

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**Measurement of Speech Intelligibility in Workplace Noise for Subjects Aged Over 50**

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The aim of this study was to check how people aged over 50 years can understand speech in noise present in workplace. For realise this purpose measurements were conducted in semi-anechoic chamber under acoustic conditions that reflect the real working environment. Noise signals emitted from loudspeaker sets situated around subject were previously recorded in real conditions. The sound pressure level of acoustic signals in the laboratory were adjusted to achieve levels measured in workplace. Material based on polish sentence matrix test was used in the assessment of speech intelligibility. Sentence tests were presented simultaneously with noise both the elderly (experimental group) and young normal-hearing subjects up to 25 years old (control group). Results showed that possibilities to understand speech in noise present in workplace for subjects aged over 50 years was lower than for control group in the same noise conditions.

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**Double Panel Structure with Active Structural Acoustic Control**

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Recently active structural acoustic control gains increasing attention in the field improvement of barriers or enclosures sound insulation. In this paper development of actively controlled structure consisting of two metal plates mounted in rigid frame and separated by air gap is presented. The structure is controlled utilizing multi channel FxLMS algorithm with three inertial magnetoelectric transducers, placed on incident plate and two piezoceramic error transducers placed on radiating plate. Exciters and error transducers are placed in regions with maximum vi-

brations amplitudes resulting from eigenfrequency excitation of the structure. Transducer placement procedure is based on nearfield acoustic holography measurements. Error signal is obtained by extrapolation of virtual microphone signal from piezoelectric error transducers. The results on preliminary tests of structure performance in the laboratory conditions are presented.

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**The Reproducibility of the Façade Sound Insulation**

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Ensuring adequate acoustic comfort in the place of residence is an important social, technical, technological and economic problem. The needs of individuals in ensuring the acoustic conditions in the apartments are vary. For this reason, the requirements for acoustic comfort should be graded from a level that ensures minimal (due to physical and mental health of the population), the acoustics in the place of residence up to the higher levels corresponding to the greater needs in this area. Translating into different technical requirements for acoustic comfort in the place of residence means a finding acoustic requirements for buildings with elevated (to varying degrees) standard acoustic and how the acoustic classification of objects according to the adopted increased requirements.

The answer to the demand for residential buildings with higher acoustic quality is prPN-B-02151-5 standard, which specifies among other course of action for the classification of sound residential buildings or separate parts or individual apartments. Acoustic tests as a basis to determine the class acoustic multi-family building, or parts of it must be carried out in respect of any consideration for protection and for each scope of protection for individual solutions covered by the acoustic requirements.

The article discusses the problem of reproducibility of test results of airborne sound insulation in the context of acoustical assessment of façade of a residential building.

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**Hearing Status in Young People Using Personal Listening Devices**

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The aim of this study was to evaluate the hearing status in young adults using personal listening devices (PLDs) in relation to their listening habits.

The study included 58 subjects, aged 22.8±3.3 years, non-occupationally exposed to noise. Questionnaire inquiry aimed at collecting personal data, the data on PLDs usage habits, self-assessment of hearing status and identification of risk factors for noise-induced hearing loss (NIHL) was performed in study subjects. Hearing tests included pure-tone audiometry (PTA) and transient-evoked otoacoustic emission (TEOAE).

All subjects were the PLDs users. Depending on listening habits they were divided in the subgroups of "regular" users ($>$ 1 h/day) and "non-regular" users ($\leq$ 1 h/day). There were no significant differences between subgroups in prevalence of NIHL risk factors and self-assessment of hearing status. However, regular users more often complained of tinnitus.

Majority (81.9%) of participants had normal hearing. Nevertheless, 6.9% of audiograms showed typical for NIHL high-frequency notches. Both, the PTA and TEOAE indicated worse hearing in non-regular users compared to regular users. No significant differences in prevalence of high-frequency notches between subgroups were noted.

The outcomes do not support some previous studies results that the excessive exposure to music listened through the PLDs might result in accelerating of development of NIHL loss in young adults.

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**Noise Exposure and Hearing Status in Call Center Workers**

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The overall objective of this study was to assess the risk of noise-induced hearing loss (NIHL) in call center operators using communication headsets.

Standard pure-tone audiometry and high-frequency audiometry were performed in 40 call center workers (age: 27.5±7.7 years, tenure: 5.4±7.2 years). Occupational and non-occupational risk factors for NIHL were identified in questionnaire inquiry. Noise exposure from communication headsets was evaluated using artificial ear in accordance with AS/NZS 1269.1:2005. The background noise present in offices was also measured according to PN-EN ISO 9612:2012 and PN-N-01307:1994. The comparison group were 53 subjects, exposed to industrial noise at similar daily noise exposure level (78.6±0.7 dB), adjusted according to age (27.6±5.7 years), gender and tenure (4.1±3.0 years).

It was found that the communication headsets generated noise at the A-weighted equivalent-continuous sound pressure levels of 58–86 dB, while the background noise ranged from 55 to 74 dB. The mean value of daily noise exposure level determined on the basis of data obtained was 77.7±0.9 dB.

In case of 88.8% audiograms average hearing threshold levels (HTLs) at 500, 1000, 2000 and 4000 Hz did not exceed 25 dB. The actual HTLs in the study group

were higher (worse) than predicted according to PN-ISO 1999:2000. However, the results of audiometry indicated better hearing in call center operators compared to the control group.

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**Noise and Infrasonic Noise at Workplaces in a Wind Farm**

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Dynamic development of wind power should take into account requirements resulting from environmental protection and human health. However in the case of occupational exposure to noise emitted by wind turbines (workplaces of turbine operation personnel, including persons performing maintenance) there are no documented data in literature in this regard. An example of pilot assessments of noise and infrasonic noise at workplaces in a wind farm is presented in the paper. The results of measurements and assessments of noise emitted by the wind turbines VESTAS V80-2.0 MW show that noise does not constitute health hazard for wind farm workers. Furthermore infrasonic noise emitted by the wind turbines VESTAS V80-2.0 MW is not a nuisance agent for wind farm workers.

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**Traffic Noise Models for Curved Roads**

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The paper presents two theoretical models for traffic noise level distribution on curved horizontal roads. In the case of vehicles moving on a given route, one can consider, in terms of sound field, that the granular traffic is equivalent for short periods with a quasi-continuous noise flow. When computing and modeling the noise level generated by traffic on roads with complex trajectory, it is common to treat the route as a sum of small lengths road segments, each being assimilated with a linear noise source. This paper started from the assumption that the route can be decomposed into a sequence of linear and arc-shaped road segments, each of them treated as a linear respectively curved noise source. An arc-shaped road segment is modeled by a tubular vibrating surface, of circular or rectangular section. In the case of rectangular section, the vibrating blade emits complex sounds on its both vertical sides and the generated sound field can be described more clearly, qualitatively and quantitatively, through intensity distribution. The theoretical models presented in the paper have direct application to the traffic noise prediction and noise maps drawing.

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**Representativeness of the Measuring Sample in the Acoustic Study of Road Traffic when Determining the Long-Term Noise Indicators**

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In the acoustic measurements of traffic noise, the long-term noise indicators $L_d$, $L_e$, $L_n$, $L_{den}$ are usually estimated based on the limited measuring sample. In order to ensure the accuracy of the estimation this sample should be representative. Lack of the sample representativeness may result in the estimation of noise indicators characterized by too large uncertainty. Thus, it might be important to find the dependence between the various periods in a calendar year: the seasons, months, weeks and days.

The article contains an analysis of a wide base of measurement data from 14-year continuous acoustic monitoring of Krakow. The analysis was performed in terms of representativeness of the measuring sample of long-term noise indicators. The paper presents some dependencies between different periods in a calendar year as well as between selected days of weeks and months. The carried out analyses indicate which periods of the calendar year should be chosen to measuring sample to make it representative with regard to the measuring point. Furthermore, the authors attempted to evaluate the possibility of using the obtained results to determine noise indicators on the roads of other categories.

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**Acoustics and Vibrations in Railway Control Centers on the Example of 10 Selected Rooms**

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The article discusses the issues of acoustics and vibrations in railway control centers. Parameters of acoustics and vibrations used to assess this type of premises are presented and their recommended values based on national and international standards are given. The article also discusses

the results of noise, room acoustics and vibrations measurements in selected centers and subjective assessment of noise by employees. The measurement results showed that both noise and acoustic properties of the rooms in most cases meet the requirements specified in the standards. However, the study indicates high levels of background noise. Only in two of tested control centers background noise levels were within the recommended range. Assessment of the vibrations impact on people in buildings showed exceedances of limit values in all tested control rooms.

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**Exposure on the Ultrasonic Noise at Workstations of Welding Machines**

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Two types of ultrasonic noise sources can be distinguished: the machines and other devices, so-called technological sources and the sources in which ultrasonic noise exists as unintentional result of work of many devices, so-called non-technological sources of ultrasonic noise. Welding machines are the technological source which emits the ultrasonic noise in the working environment. Noise with components of high audible frequency (1016 kHz) and low ultrasonic frequency (20–40 kHz) is considered in Poland as ultrasonic noise. Ultrasonic noise is one of dangerous factors which cause annoyance effects (problems with attenuation and communication) or dangerous effects (occupational hearing loss) on the human body. The main aim of this paper is to present the measurement results and the assessment of ultrasonic noise at chosen welding workstations. Most of test results carried out within the study confirmed that this type of noise constitutes a hazard factor in the working environment. Examples of technical prevention activities for workers' protection against the effects of exposure to ultrasonic noise at welding workstations are presented in the article.

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**The Use of Kernel Density Estimator to Determine the Confidence Intervals for Long-Term Noise Indicators**

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The non-classical model of interval estimation based on the kernel density estimator is presented in this paper. This model has been compared with interval estimation algorithms of the classical (parametric) statistics assuming that the standard deviation of the population is either known or unknown. The non-classical model does not have to assume belonging of random sample to normal distribution. Theoretical basis of the proposed model is presented and an example of calculation process which makes possible determining confidence intervals of the expected value of long-term noise indicators LDEN and LN. The statistical analysis was carried out for 95% interval widths obtained by using each of these models. The inference of their usefulness was performed on the basis of results of non-parametric statistical tests at significance level $\alpha = 0.05$. The data used to illustrate the proposed solutions and carry out the analysis were results of continuous monitoring of traffic noise recorded in 2004 in one of the main arteries of Kraków, Poland.

Keywords: long-term noise indicators, non-classical statistics, interval estimation, kernel density estimator.

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**An Investigation of the Influence of Beam Geometry on the Acoustic Response Due to a Moving Oscillator**

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The acoustic response of simply supported beams due to a moving oscillator is presented in this paper. The response of uniform and non-uniform beams is analysed to predict the influence of beam geometry on the sound pressure radiated when the beams are subjected to excitation caused by the moving oscillator. Though similar studies on the vibro-acoustic responses of beams due to moving point loads have been reported, this is the first time that an investigation of the effect of geometry on the sound radiated by a beam due to the excitation caused by a moving oscillator is carried out. Sound pressure levels (SPLs) at different locations above the beam surface are determined by evaluating the Rayleigh surface integral. Effects of damping and oscillator speed on acoustic radiation are predicted. The beams are so chosen that all of them have the same mass, length, width and material properties. The only parameter that is varied is the height (depth) of the beam. The study reveals a very significant fact that just by changing the topology of a beam without causing any change in its mass (i.e., by neither adding nor removing any material) or material properties, the acoustic responses can be controlled. This study helps in identifying a desirable geometry of the beam for which the acoustic responses due to a moving oscillator are minimum. The analysis is relevant and has practical applications as it is directly related to the control of noise emanating from railway bridges due to rail car excitation.

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**Theoretical and Experimental Modal Analysis of an Acoustic Guitar**

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The guitar is a complex vibrating system with four major components: the top plate, back, sides and neck.

Since most of the sound is produced by the top plate, its natural frequencies and mode shapes, as well as those of the body were obtained through finite element modelling (FEM) and were validated through experimental modal analysis. Only linear models and one kind of boundary condition, i.e., the guitar resting on the thigh of a seated player were considered. The geometry was created using Commercial CAD software system, SolidWorks 2012 and it was imported into ANSYS to build the finite model. SOLID45 element was used for meshing. The first five normal modes in the frequency range up to 1200 Hz were extracted from the FE simulation. For the experimental modal analysis, signals form a roving hammer and a stationary miniature accelerometer were fed into a data acquisition system to obtain frequency response functions (FRFs) from which natural frequencies and mode shapes were extracted. Chladni patterns of the mode shapes of the guitar were also obtained by sprinkling fine sand while subjecting the guitar to shaker excitation. Finally parametric studies were conducted to analyze the effect on the natural frequencies and mode shapes of the following: (i) material of the guitar namely Rosewood, Mahogany, Ebony, Composite and Foam, (ii) diameter of the sound hole, (iii) vertical distance of the centre of the hole from the top and (iv) horizontal distance of the centre of the hole. Such a study has not been reported elsewhere.

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**Autonomous Remote Monitoring System to Control Noise and Vibration Hazards in the Working Environment**

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Exceeding the limit values for noise and mechanical vibration can lead to serious health consequences. For this reason, vibroacoustic parameters should be monitored continuously in the working environment. This paper presents concept and construction of remote monitoring system to control noise and vibration parameters. The system was constructed on the basis of energy harvesting technology and consist of autonomous measuring devices powered by generators which use renewable energy sources. The system use a variety of measurement devices to measure and evaluate parameters characterizing mechanical vibrations and noise in the working environment. The measurement results are transmitted wireless to the system's main unit with the appropriate software, where current measurement result or the results of previous measurements for any selected period of time can be viewed. The system allows to analyse the results including identification of a place and workers exposed to vibroacoustical hazards.

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**Comparison of Computational and Actual Sound Levels Wind Turbine Farms**

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The study compared the levels of sound coming from wind turbines, which were obtained by calculation (simulation) and sound levels determined during field tests on acoustic wind farm. The range of noise from wind turbines obtained simulation methods for 3 different coefficients of absorption by soil and using the so-called G. an alternate method. Simulations were performed, assuming that the turbine is an omnidirectional point source of a certain sound power level specified by the manufacturer located at the height of the nacelle of a wind turbine. Real noise measurements on an existing wind farm were to evaluate the acoustic in 3 different times, where special attention was paid to the wind speed at a height of 4 meters above the ground and at a height of 100 meters – the height of the generator. To fairly compare theoretical and actual sound levels, acoustic wind turbine simulation model adapted to the levels of sound power turbines working on a wind farm. Such a calibration model calculation was made possible by data from the SCADA system, supervising the work of wind turbines, including the current wind speed at the height of the nacelle of a wind turbine.

Keywords: wind turbine noise, simulations, field noise measurements, forecasting range.

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**A Hybrid Active-Passive Noise Control System Using Vibration Measurement**

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This work presents a hybrid active-passive noise control system for HVAC ducts. The designed structure has been optimized for airflow and it combines a physical noise absorber and an active noise control module. As the passive section is able to create sufficient attenuation of high frequencies the bandwidth requirements for the active component can be drastically reduced. This makes a set of accelerometers available source of information on acoustic noise propagating inside the duet. The superiority of such approach over a classical one with microphones it that vibration measurements do not suffer from the airflow. However the acquired signals require additional processing.

In the paper the results of experimental tests of performance of the active noise control component of the hybrid system are presented. The tests were performed at a large cross-section laboratory HVAC installation will significant airflow. The vibration measurements are used to estimate either the reference signal or the error signal for the ANC system.

Keywords: active noise control, passive absorber, HVAC system, acoustic duet, vibration measurement.

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**On the Noise Hazard Assessment within the Intermediate Range of the High Audible and the Low Ultrasonic Frequencies**

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In parallel to the ultrasonic noise assessment procedures and research activity in the field there have appeared several papers in the domain so called high-frequency audiometry which covers the range of frequencies 8–20 kHz. They are important for recognizing the harmfulness and hazard of the audible high frequency sound components in the same range as the one of the low frequency ultrasonic noise. On the other hand there exists a certain inconsequent situation in the general approach to the problem of ultrasonic noise hazard assessment in work places environment which concerns the convention to include the frequency range of 10–20 kHz to the domain of ultrasonics. The range consists of one third octave bands of central frequencies: 10, 12.5, 16, 20 kHz and conventionally is called as low frequency ultrasonic noise though at least the components of the two lowest bands are naturally audible by a majority of population (mainly young people).The paper presents a discussion related to some achievements of the two domains and some conclusions which could be useful for a more consequent description of the subject. and perhaps could be taken into account in the regulations being prepared for the ultrasonic noise assessment in work places environment.

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**Noise Zones at Shale Gas Drill Site**

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The subject of studies is noise hazard on workers on the premises of exploratory shale gas drill site. Noise on workstations at shale gas is characterized by big variability of sound pressure level in time. This variability results from different operations at boreholes (deepening of borehole, releasing and drawing of drill pipes, milling, fracturing etc.) and the fact that workers work at different place, where the sound level is not the same. One of typical operations is drilling the borehole. Results of measurements and noise exposure assessment on workstations during drilling operations are presented. Standard 12 hours work shift during 14 days (next 14 days are off-duty) for worker on shale gas was used for assessment. At drill site there were noise zones where A-weighted sound pressure level exceeded 85 dB. Research shows that at shale gas drill site even employees performing conceptual tasks may be exposed to the hazard of hearing loss if they spend a part of their working time in noise zones where noise exceeds 85 dB. There also presented identifying the source of noise of the drill site. From these measurements it follow that the internal combustion engine driving Top Drive generator is the biggest source of noise, the second are mud pumps and the third source are vibrating sieves.

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**Practical Experiences of Structure-Borne Noise Measures for Building Constructions**

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By global trend of urbanization cities worldwide are still growing. This growth meets more complex situations than growth was in former times with mostly only spreading to wider areas, Today cities develop within a complex system of already existing buildings, facilities and transportation infrastructure. Based on this area of tension noise and vibration, sufficient working measures are getting more and more into the focus of building development and construction. This lecture deals with a brief overview of taking action for vibration isolation of entire buildings from the point of view of an isolation material manufacturer.

Infrastructure and transportation lines are sources for initiation for vibrations in the ground. Most powerful isolation measure against spreading of vibrations would be isolation at the source of vibration like a light-mass-spring system for trams, but these measures haven't been installed very often in former times. If no isolation at source of vibrations or within the transmission path is possible the principle of resilient bedding of building as isolation measure can be the solution to prevent intruding structure-borne noise into building constructions. Different ways of resilient bedding of a building and special planning process including taking weight of building and spreading of pressure into account lead to individually designed solution. Worldwide experience shows that each and every building isolation project is different with its different needs concerning the use and issues caused by trams, subways, trains or even train stations.

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**Feedforward Control of a Light-Weight Device Casing for Active Noise Reduction**

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By appropriately controlling vibration of a device casing, it is possible to enhance acoustic isolation of the de-

vice from the environment. The sound insulation efficiency of this technique for a rigid casing was confirmed by the authors in previous publications. In this paper, an elastic light-weight casing is investigated, where vibrational couplings between walls is much greater due to lack of a rigid frame. For successful reduction, a control system is required that involves the cross-paths, what complicates its structure and highly increases the computational complexity. To satisfy the real-time requirements of the control system, techniques to reduce the computational effort are employed. Multiple vibration actuators are installed on each of the casing walls. An adaptive control strategy based on the Least Mean Square (LMS) algorithm is used to update control filter parameters. Obtained results are reported, discussed, and conclusions for future research are drawn.

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**Cumulative Industrial Noise Impact on the Environment**

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The existing Polish legislation contains provisions on the need to take into account cumulative environmental impacts, but the lack of specific legislation makes the assessment of such impacts are executed summarily, and sometimes even are not executed. This situation also applies to noise impacts, where in addition to the general difficulties, there is still the problem of varying parameterization (and annoyance) of the different types of noise and the associated lack of possibility "simple" aggregation of their effects. In the case of acoustic impact in practice we always have to deal with summing up different sounds, but classification of these sounds is subjective and depends on many factors, objective and subjective.

Nevertheless, there is a need for an objective approach to the determination of an objective parameter that enables summation of component effects not only the physical (energetic) but also the psychoacoustic, at least in the range of one type of noise. As part of this study will be analyzed the effects of the additive cumulative impacts of industrial noise without taking into account additional (synergistic) the impact of other types of noise sources, e.g. traffic and rail noise. The paper contains examples for determining the cumulative impact of existing and planned facilities.

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**Analysis of Selected Cases of Impulsive Noise in Transport and Industry**

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The paper presents the work on the problem of impulsiveness assessment in environmental noise coming from the selected sources: traffic and rail transport and from the industry. Inclusion of the impulsiveness in the assessment of noise in Poland is mandatory, but the problem is the qualification of the impulsiveness and applying an adequate adjustment. Currently there are no algorithms that would allow to classify them on the basis of measurable physical characteristics of the impulses, furthermore, the arbitrary classification covers only a few specified sources. For those indicated sources, there are doubts in the applying of adjustment in the situations when impulses are masked by the ambient noise, while for others, not mentioned in the standards for impulsive noise, it is difficult to assign them to appropriate category in general.

The paper presents the results of research on impulsive noises coming from traffic noise – the passages through bridge expansion joints; from railway noise – the passages through railroad switches, and from industrial noise – sources not indicated in the national standards. Authors proposed the extraction of the physical characteristics of impulses, which may lead to differentiate them according to the environmental annoyance.

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**Hearing Status in Young People Using Portable Music Players – a Pilot Study**

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The overall objective of this study was to evaluate the prevalence of noise-induced hearing loss (NIHL) in young people using personal music players (PMPs).

A pilot study was carried out in 67 subjects, mainly students, aged 22.8±3.3 years, non-occupationally exposed to noise, including excessive sounds due to playing instruments. Standard pure-tone audiometry and questionnaire inquiry aimed at self-assessment of hearing status and identification of risk factors for NIHL were performed in study subjects. Data on their habits concerning usage of PMPs were also collected.

Generally, over three-quarters (77.6%) of study subjects declared frequent usage of PMPs. Moreover, 35.8% of them reported listening (for at least an hour) every day to personal media players. On the other hand, a relatively small fraction of respondents declared the frequent attending music clubs and pubs (4.5%), usage noisy tools (11.9%) and practice noisy motor sports (16.4%).

Almost all subjects (91.8%) had normal hearing (hearing threshold levels in the frequency range 250–8000 Hz $\leq$ 20 dB HL). However, 9.0% of audiograms showed typical for NIHL high frequency notches (mainly occurring at 6000 Hz). Furthermore, some of study subjects reported hearing impairment (14.9%) and complained of difficulty in speech intelligibility in noisy environment (29.9%), hyperacusis (11.9%) and tinnitus (4.5%).

The obtained results confirm the need of further studies aimed at evaluation of the hearing status and exposure to excessive sound in young people regularly using portable music players.

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**The Results of the Measurements and Analyses of Impact of Wind Farms on Acoustic Climate**

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Noise emitted to environment is one of the basic factors connected with wind farm operation. That is the reason why each wind farm localization should be analysed to assess the impact on environment considering noise. At the stage of the project, the prognosis of localization results considering emitted noise may be only predicted theoretically, mostly by computer simulation. The existing farm can be assessed by performing local measurements. Conducting local measurements of wind farms, minding the specificity of their work, requires generally applied and suggested modifications of noise measuring methods. The basic problem while carrying out noise measurements is choosing the proper wind speed, which should not exceed 5 m/s at the height of measurement point (usually 4 m). In the article there are presented examples of own local measurements conducted at more than 10 big wind farms. It was proved that at the distance of more than 500 m from the farm, lots of results of measurements are comparable to measurements of existing acoustic background. For cases when noise measurement results, including background noise, were unrecognizable when compared with only acoustic background and the values were lower than permissible level in the measurement point, some interpretations of such situations were suggested.

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**Everyday Exposure to Infrasound Noise**

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Infra-sounds are very common in natural environment. There are various opinions about their harmfulness or lack of harmfulness. One of the reasons of increasing interest in this issue is that there are more and more wind farms appearing close to building estates which are undoubtedly a source of infrasound. It is reasonable to present the results of research of infrasound noise connected not only with wind farms. In this study there are presented own results of research of infrasound noise related to daily human activity. The measurements were carried out during housework, travel to the office or shop and during shopping. The results are shown in a form of values of equivalent levels and octave analyses. Taking into consideration natural sources of infrasound in environment, the measurements were conducted during both windy and windless weather. On the basis of results of the measurements it was possible to define the daily exposure to infrasound noise. Those results were also compared with threshold values sensed by people, which are available in literature. Estimated level of exposure to noise beyond workplace together with the level of exposure to noise at work enables to define daily exposure level and in the same better assessment of risk of health loss. Increasing social awareness of acoustic threat in everyday life allows us to identify the problem and in the same improve the quality of rest and efficiency at work.

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**The Research of Materials for Protection Against Mechanical Vibration at Workstations**

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The paper presents the developed method of testing anti-vibration material properties. The method is based on determining the transmission of vibrations. It has been described a test bench based on a system of vibration generation made by IMV. The measurement system has feedback circuit and compensation system of static load using a pneumatic system. The paper also presents how to press samples during tests using developed adjustable mass. Test results were performed as average values of vibration transmissibility calculated for tested material samples. Comparison of the results obtained for different material samples confirms the assumption that the load change of the sample, in most cases, substantially affect the damping of vibrations. It has been found that it is not possible to determine a trend and the range of such changes for all tested materials.

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**Noise Control Transmission Methods of the Combustion Engine by Means of Vibration Reduction**

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The transmission of vibroacoustic energy from a combustion engine unit to the surrounding environment is largely dependent on the unit mounting, the transmission paths and on the construction of the vehicle chassis and/or

surrounding structures. Especially with low speed engines where generation of noise is perceptually weak in the vehicles protected area, but inherit strong low-frequency waves whose energy can negatively impact human health, comfort, driving safety and reliability during longer rides or prolonged proximity to the source. The main aim of this article is to analyze the components of the engine unit, which have a deciding impact on the reduction of low-frequency waves. Thus, it is analyzing the structural borne noise transmitted from the engine unit to the surroundings of the passenger vehicle. The results of the vibroacoustic measurements are compared to modal analysis to obtain the possible resonance sources of the car body and/or assessing the influence of the vehicles safety components on the generated vibroacoustic energy transfer into the protected area of the passenger vehicle. Measurements were made on a passenger vehicle at rest at the most frequent operational engine speed and for a stationary engine in a boiler plant. For the detection of the vibroacoustic energy sound pressure level and mechanical vibration FFT analysis was used. Primarily the low-frequency noise sources are specified and the direct effects on human health were investigated. Finally, this paper suggests some measures which can have an impact on the reduction of undesirable vibroacoustic energy within the protected area.

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**Detection and Recognition Thresholds of Sound Effects**

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Detection and recognition thresholds were assessed for eight sound effects recorded with a dummy head in natural acoustical conditions. The sounds were chosen on the basis of their common occurrence in everyday life. For each sound effect a psychometric function for recognition was determined with the use of an 8-AFC, forced-choice procedure. The recognition threshold was taken as the signal level corresponding to 56.3% of correct responses. Detection thresholds were measured with an adaptive, 2-AFC staircase procedure that estimates the signal level at the 70.7% point on the psychometric function. The measurements of recognition and detection were made for 15 listeners: five naive listeners, five musicians, and five sound engineers. For each sound and each listener the difference between recognition-detection gap, called the recognition-detection gap, was calculated. It was found that the size of recognition-detection gap varied among sounds; some sounds were recognized practically at the detection threshold level whereas for other sounds the recognition-detection gap was larger and exceeded 5 dB. The study revealed no systematic differences in the recognition-detection gap between naive listeners, musicians, and sound engineers. However, the comparison of data across those groups has only a limited validity, due to a small number of listeners who took part in the experiment.

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**Cumulative Level Distributions of Orchestra Sound on Stage**

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Exposure of student musicians to sound was measured during concerts and rehearsals of a symphony orchestra, a wind orchestra, and a big-band. The measurements have shown that musicians were exposed in many cases to sound levels exceeding the permissible daily exposure level of 85 dB(A). Such excessive levels were found in the case of musicians playing brass, woodwinds and percussion instruments and also musicians who were seated in immediate vicinity of those instruments on the stage. It has to be noted, however, that the sound levels considerably fluctuate during music performances. The distributions of sound levels during the concerts and rehearsals measured in the present study showed that, depending on the instrument, the level of 85 dB(A) was exceeded only in 15% to 55% of the performance time. Such a temporal variability of sound levels in music may explain why musicians generally have milder hearing deficiencies than industry workers exposed to similar doses of stationary noise.

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