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C H R O N I C L E

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Abstracts

1. Analysis of load and technical condit impact on acoustic field distribution in an environment

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Noise sources located in the power objects are characterize with high level of acoustic power and wide range of frequency. It causes that those acoustic sources have a significant impact on shaping the acoustic climate around the adjacent areas, what forces a limitation of over standard noise emission. It is possible to carry out proper analysis of identification of important noise sources as well as a selection of parameters for reducing measures with a greater certainty when uncertainty in determination of noise emission is reduced and when its identification in a function of load changes and technical condition is additionally made. Neglecting the above mentioned functions resulted so far in an improper selection of materials and geometrical design features, especially in the case of passive reducing measures, what was a reason of increase of protection costs.

The intensity method in closed rooms and pressure method in case of open area were used during experimental testing. Range of measurements was limited only to crucial sources, which are then planned to be modelled in an integrated acoustic model, which includes the surrounding environment. Both calculation model and experimental tests will be made for different technical conditions and load, what will enable to develop the general calculation model of acoustic field distribution in an environment.

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2. Hand vibration – operator's palm clamp effect

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Nowadays in order to estimate vibration level on hand tool operator we only measure tool vibration. In this method a very important factor indicating constraints between hand and tool is not taken into consideration. The purpose of this article is to examine the way the power of clamp influences tool vibration and hand vibration. Authors used relevant method described in PN-EN ISO 5349. A new algorithm with wavelet transformation was another factor applied. Each signal was recorded by our original measurement system.

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3. Analysis of sources for structure-borne noise

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Acting on the source is a major way to reduce noise of equipment. In order to orientate such actions, sources are usually classified according to the "natures" of noise which are solid-borne, liquid-borne and airborne. Solid-borne noise is a wide family as it includes mechanical phenomena. Litterature and standards about noise control engineering pay attention to solid-borne noise; but the reader may be disturbed by confusions: excitations, vibration, transmission and radiation are often mixed in the "solid-borne" noise concept. A classification based upon basic mechanical parameters could allow a rigorous classification of phenomena; this classification would follow the successive steps of the global solid-borne noise generation. Dedicated analysis tools correspond to each of these steps; they bring specific methods of noise reduction. A promising way is to act on the first step of noise generation, which is the excitation source. Tools dedicated to excitations analysis are used in various noise and vibration applications domains. They may use signal processing or force determination methods. A panel of industrial examples is given.

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4. Vibration energy flow in joints of plates

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In this article, active noise reduction system has been described. The ANR system was made on basis of finite impulse response filter and realised algorithms LMS or NLMS. The algorithms were implemented on the dSPACE card with floating-point processor TMS320C31.

Researches were performed in the anechoic chamber and in the enclosure of dimension $4.4 \times 3.05 \times 3.2$ m and reverberation time $T = 0,53$ s. White noise filtered by third and octave filter with mid-band frequency 125 Hz was used for the experiments.

The ANR system working in free field conditions (in the anechoic chamber) allowed to obtain the average acoustic pressure level reduction ranging from 9.1 to 24.1 dB for octave, and 14.7 to 23.1 dB for third octave.

Measurements carried out in natural acoustics conditions in a selected room allowed to obtain the following values of average acoustic pressure level reduction: for octave from 2.2 to 14.2 dB, and for third octave from 6.4 to 19.8 dB.

The result of experiments proved that the convergence time of NLMS algorithm was several times shorter than convergence time of LMS algorithm.

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5. Determining the noise impact on hearing employing psychoacoustical noise dosimeter

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This research study presents the engineered noise dosimeter based on psychoacoustical properties of the human hearing system and, at the same time, evaluation of time and frequency characteristics of noise.

The designed noise dosimeter enables to assess temporary threshold shift (TTS) in critical bands in real time. In this way it is possible to monitor the hearing threshold shift continuously for people who stay in the harmful noise conditions. Moreover, the psychoacoustical noise dosimeter provides the functionality which determines time sufficient for increasing the assumed hearing threshold shift along with time required for recovery of a hearing threshold toward its initial value. Noise exposure level and duration along with hearing examination have been first obtained in the acoustically controlled environment. Pure-tone audiometry has been used for hearing examination. This has been conducted in constant time intervals, during noise exposure as well as during resting time (time required for hearing recovery). The examination aims at measuring hearing threshold at 4 kHz. The important part of this study is validation of the dosimeter performance in the real noise exposure situation. In this case the whole noise measurement scenario encompasses both noise exposure effects, and hearing examination before and after noise exposure. The hearing examination has been extended by the distortion products otoacoustic emission method (DPOAE). The measurement results obtained in real conditions have been compared with those which were computed by means of the presented psychoacoustical noise dosimeter.

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6. Studies on propagation of vibroacoustic energy in a large-size object

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Large-size spaces of general use are usually characterized by atypical acoustic features. The Great Lecture Hall of Warsaw Technical University can be an example, as its maximum crosswise dimension is comparable with its height. When powerful amplification equipment is used for special events, the question that arises is possible negative influence of acoustic signal energy on the building's structure, especially the skylight. The paper presents selected results of studies on acoustically induced vibrations of construction elements and tries to answer the above formulated question.

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7. An optimal method of assessment the individual susceptibility to noise-induced hearing loss

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The aim of the investigation was to compare different methods of subject classification regarding susceptibility to noise induced hearing loss in group of 949 workers of power plant. In the first two methods, simple and accurate the classification was performed according international reference standard ISO1999:1990. In the tree other methods the entire group of workers was divided into subgroups to obtain similar distribution of age, time of employment and level of noise exposure in the susceptible and resistant group. In the first two classifications the susceptible group was significantly younger then resistant group, had shorter time of employment and lower level of noise exposure. This findings are in line with the definition of increased vulnerability to noise inducted hearing loss. Additionally, an excellent separation between hearing thresholds (HTs) of the susceptible and the resistant group was achieved. All three other methods resulted in worse separation of HTs between susceptible and resistant group of subjects. Subjects pre-selection deteriorates the reliability of workers' dichotomization into noise-susceptible and noise resistant groups.

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8. Sources of vibroacoustic hazards in open-pit mines of mineral raw materials

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Many sources of vibroacoustic energy manifest in open-pit mines of mineral raw materials. Noise and vibrations are the reasons of occupational diseases and injuries at work. Exploitation of open-pit mines of minerals constitutes hazards not only at workstations but also for the natural environment. Kinds of noise sources depend on the technology applied in open cast mining. Noise levels often exceed the permissible values. Besides high noise levels values of vibrations – general and local, – which are the highest during processes of mining, loading and transporting are also significant. Among machines and devices used at raw material mining the highest noise is caused by crushers, dumping conveyers, bulldozers etc. Blasting works are the source of short-lived noises however, characterised by high levels of acoustic pressures. Identification of sources of vibroacoustic hazards occurring in one of the open-pit mine is presented in the paper. The obtained results of measurements of noise levels generated by sources of continuous and impact noises are also given.

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9. Vibroacoustics models of the selected human larynx diseases

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Development of the digital registration and processing speech methods enables presently objective acoustic diagnostic methods of medical diagnosis. These methods prove useful due to the fact that all pathologies and diseases of with the human vocal tract have influence on the quality of the patient's speech signal. Diagnostics of the voice organ could be defined as the unambiguous recognition of the current features condition of the particular voice source. Such recognition is based on essential acoustic parameters in the speech signal. Using this method requires creating vibroacoustics models of the selected deformations of the Polish speech as related to particular human larynx diseases. In this present paper a method of processing the speech signal in the 29 dimension space is reviewed. Analysis and mapping were executed in the time, frequency and cepstral (quefrency) domain. The applied mapping enabled to qualify symptoms and conditions of the selected human larynx diseases as observed in the acoustic speech signal. Graphic interpretation of the parametric models of such diseases as laryngeal cancer, laryngeal polypus and chronic laryngitis is presented. Additionally a quantitative estimation of similarity and the size of the differences of the deformation speech measure in the relation to the correct speech were executed. A database of healthy women and men correct speech, without pathologies that could influence the quality of the voice was used as a standard of correct Polish speech.

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10. Noise sources location in fluid power machines

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In this paper, the noise generation mechanisms and techniques for noise reduction in fluid power units have been described. Using the sound intensity method, the major noise sources in fluid power unit can be identified. It has been proved that components of power units with larger sound radiating surfaces such as the electric motor and the oil reservoir produce the major part the global noise radiation.

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11. Central auditory damage induced by solvent exposure

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Different studies have demonstrated that solvents may induce auditory damage. It has been suggested that part of this damage may be localised in the central auditory pathways. The present study aimed to investigate possible auditory processing disorders related to solvent exposure. Thirty solvent-exposed workers and thirty age and educational level matched controls were selected to participate in the study. To select participants, a questionnaire, otoscopy, pure-tone audiometry and tympanometry were carried out. Filtered speech (FS), Random gap detection (RGD) and Hearing-in-noise (HINT) tests were conducted with the selected participants. Both groups of workers presented with mean normal hearing thresholds. However, significant differences between groups were observed for FS, RGD, and HINT. It is concluded that auditory processing disorders may be associated with solvent exposure.

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12. Applications of sensitivity analysis in testing of active noise reduction systems

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Method of testing of active noise reduction systems based with use of sensitivity analysis is presented in this paper. For the analysis, in suggested method of research dependences described as block diagrams of transfer function were applied. Associated sensitivity models were defined with the use rules of transformation of these diagrams. Model of active noise reduction system analysis was based on the associated sensitivity models.

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13. Cooperation of notified bodies under EU directives 89/686/EEC, 98/37/EC, 2000/14/EC on the national and European level

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According to the guide published by the European Commission on the implementation of directives based on the concept of new and global approach, the notified bodies should participate in the coordination actions related to their scope of notification. The participation in the committees and groups coordinating

the activities of notified bodies on the international and national level ensures the maintenance and development of technical competencies necessary to carry out conformity assessment and enables the application of unified technical rules included in new approach directives.

Horizontal Committee for Personal Protective Equipment coordinates on European level the cooperation of notified bodies under the directive 89/686/EEC and Horizontal Committee for Machinery coordinates the cooperation of notified bodies under the directive 98/37/EC. The cooperation of notified bodies is also carried out within Vertical Groups composed of experts representing all notified bodies in the area of the assessment of particular product types. The cooperation of notified bodies performing conformity assessment of equipment that is subject to the reduction of noise emission under the directive 2000/14/EC is carried out within the NoiseBody group.

On the national level the cooperation of notified bodies is carried out within the frames of *Agreement of Polish Notified Bodies for Personal Protective Equipment* under the directive 89/686/EEC, created on CIOP-PIB initiative. The cooperation of notifies bodies for machinery is carried out within the National Consultancy Forum on European Union legislation related to machinery, which is part of Technical Safety Centre.

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14. Infrasonic noise at workstations of drivers of road vehicles – assessment of exposure

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Infrasonic noise is one of the most harmful and annoyance factors in a working environment of drivers. This paper presents the general diagram and preliminary results of study of infrasonic noise that occurs at the work stations of road vehicles drivers. Measured infrasonic noise level (equivalent continuous G-weighted sound pressure level normalized to a nominal 8-h working day $L_{\mathrm{Geq,8h}}$) at a bus driver's workstation is between 109–112 dB and permissible value in this range ($L_{\mathrm{Geq,8h}} = 102$ dB) is exceeded. There is presented spectrum of low frequency noise (including infrasonic noise) inside a city bus and a small truck. The main components of spectrum (sound pressure level is between 95–97 dB) are in infrasonic noise range (12.5–16 Hz). There is also presented infrasonic noise level depending on rotary speed of motor and with relationship for a vehicle travelling.

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15. Analysis of annoyance of low-frequency noise – tests in laboratory conditions

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This paper presents the results of low-frequency (including infrasonic) noise annoyance test in laboratory conditions on a model workstation, where conceptual mental work that requires great concentration of attention takes place. Group of volunteers: 60 persons (30 women and 30 men) participated in the experiment consisting in completing psychological tests in three different acoustic conditions. The test results have shown significant differences in subjective assessment of noise annoyance depending on the gender and reactivity level of surveyed persons.

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16. Microturbines in dispersed cogeneration – vibroacoustic threats

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The article discusses tendencies in development of turbines, from the macro to micro scale, and their possible application in dispersed cogeneration, i.e. in home power installations. In the small scale, turbines and bearings are a source of specific problems connected with securing stable rotor operation and their susceptibility to some material imperfections, such as shaft cracks. New research tools composing the computer system MESWIR are presented, and results of system stability investigations taking into account thermoelastic deformations of bearing bushes and various variants of their fixing are discussed, along with the results of investigations of the effect of crack depth propagation on the dynamic state of the entire system. The obtained results are rather surprising and frequently in opposition to a so-called engineering intuition. The machine selected for investigations is a three-support rotating machine with two discs, in operation in conditions specific for microturbines (low Sommerfeld numbers). The developed research tools have turned out extremely applicable for assessing vibroacoustic threats generated by this type of machines.

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17. Noise hazard to the population of areas connected with functioning of roadway frontier crossings

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In spite of Polish observing the *Schengen Convention* connected with the freedom of internal moving in European Union, the problem of operating the external frontiers is still valid. Such border crossings can be crossed only at the special border crossing points and in defined time. The controls over them are executed according to uniform criteria. As long as the political situation in Europe is not change, Poland will stay as the border's state of E.U. and people will be put at risk of the border crossing action.

The noise connected with border crossing functioning is emitted at whole border crossing – at all developed area and routes lead to it. It is not only the border crossing point itself but also all grounds which come under it.

The conducted researches have shown that noise connected with border crossing functioning could be troublesome for the inhabitants of border areas. The problems of exceeding the maximum permissible level of noise on protected areas are mainly connected with many sources of noise producing, for instance lorry type vehicles. On the basis of filled questionnaires it has been found that noise is an important problem for the border areas inhabitants. The scale of the disaster requires taking preventive steps.

The problem of many noise sources seems to be quite serious because the Polish border is 3500 km in length and there are 200 Polish border crossings.

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18. Vibration and noise in road vehicles

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This article presents evaluating of mechanical vibration and noise influenced on drivers of various road vehicles. This evaluation has been developed on the basis of the results of field investigations. Studies

at selected workstations showed that hazards caused by hand-arm and whole-body vibrations were comparable. Noise in almost all cases was under limit value (maximum admissible intensity of agent harmful to health in the working environment). Although vibration or noise have not exceeded limit values, workers complain of diseases related to effected vibroacoustic agents. The standard methods do not allow to evaluate the risk of vibration and noise diseases caused by the combined influences of both kinds of vibrations and noise which exist simultaneously.

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19. Laboratory objective method for noise reduction measurements of ear-muffs

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The aim of the project was to work out a laboratory method for measurements of noise reduction of ear-muffs whose results are in better agreement with real-world performance than the results of sound attenuation measurements according to PN-EN 24869-1. The paper presents the methodology for noise reduction measurements of ear-muffs with the use of a four-channel sound analyzer. The laboratory test site met the requirements of PN-EN 24869-1. The objective tests were carried on with sixteen persons. The microphones were placed at the subject's ear under the ear-muffs' cups and outside the cups. The measurements were carried on four samples of ten models of ear-muffs. The comparison of noise reduction measurements data with the sound attenuation measured according to PN-EN 24869-1 is discussed.

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20. Complex noise indicator for noise mapping based on the EU working groups' and Polish results of the annoyance investigations

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The Noise Directive 2002/49/EU includes obligations for noise mapping for agglomerations above 250 thousand citizens in the first step and later – above 100 thousand people. The noise map of the city consists of, at least, 4 layers of information. Each layer, in graphical form, represents different kinds of noise distribution, for traffic, railway, air and industrial noise.

One can ask how to assess the complex exposure for all noises from all layers of the map? The proposition of the complex index evaluation is developed in the paper. At first, it was assumed that the basic indicator for complex description of the acoustic conditions is the sum of the weighted noise exposures connected with the L_{DWN} level from different category of noise. The weights for the complex indicator were worked out on the basis of the results of the noise annoyance investigations, carried out by the European Working Group on health and socio-economic aspects, published in position papers (year 2002 and later).

However, one can ask if the European relation between noise levels and noise annoyance is correct for Polish conditions?

In the second part of the paper the results of the comparisons between EU's and Polish annoyance curves are presented. The curves were obtained as the correlation's product of the subjective assessments (query) and L_{DWN} levels measurements and calculations. These investigations in Poland were carried out as a part of the annually project called "Noise Monitoring System" (coordinated by Chief Inspectorate of Environmental Protection). Their background results are characterized in the paper.

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21. Attenuation of road traffic noise by a vegetation belt of Lantana Camara in Dehradun, India

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Road traffic noise levels were measured in the front and rear sides of a 15 meter thick vegetation belt of Lantana *camara* in a suburban area of Dehradun, India. Overall attenuation of A-weighted noise levels computed for noise events identified on the basis of L_1 levels was found to be 14.8 dBA. Noise measurements at different 1/3 octave frequencies were also made to evaluate spectral characteristics of traffic noise attenuation by Lantana *camara*. Computation of excess attenuation from the measurements of noise spectra indicated that maximum excess attenuation of 11 dB occurs in the low frequency range at 200 Hz. Between 400 Hz to 3.15 kHz, excess attenuation varies in the range of 5–9 dB. Another maximum in excess attenuation ($\sim$ 14 dB) is observed in the frequency interval 6.3 kHz to 12.5 kHz. The results are consistent with the results of some of the earlier studies which indicate that vegetation belts are more effective in attenuating noise in the low and high frequency range and comparatively less effective over the middle frequencies. Nevertheless, the attenuation achieved over the entire audible frequency range, in general, is still significant enough and provides sufficient basis to explore the effectiveness of vegetation belts consisting of some other plant species for the purpose of providing noise barriers along the roadsides.

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22. Noise reduction of spiral ducts

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The paper presents noise reduction (NR) as result of computational modeling of acoustic wave propagation in spiral ducts. 3D models were created by the use of the Finite Elements Method (FEM) in computer application COMSOL Multiphysics. 9 models of spiral ducts with increasing from 1 to 9 number of spiral leads are considered. Time harmonic analysis was used to predict noise reduction, which is shown in spectral and interval frequency band. Spiral duct performance can be observed as a comparison between noise reduction before and after change from circular into spiral duct.

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23. The assessment of the real protective properties of PPE and the representativity of the test methods

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The assessment in laboratory of the efficiency and comfort of PPE remains, in many cases, rather theoretical. The standardized tests methods adopted and used, as a basis for this assessment are very often empirical and simplistic. This was often the only way for standardizers to get repeatable, reproducible and unnecessary expensive tests. Nevertheless they often give overestimated results; PPE having satisfied all the tests in laboratory may sometimes appear in real conditions of use, less efficient and comfortable than expected.

To reduce as much as possible these discrepancies, it is always advisable to try to correlate the results obtained in laboratory with the reality of the work places by conducting assessments in real situation of

use of PPE. These differences mainly exist when the real PPE performances are closely linked to the morphological and psycho-physiological characteristics of the future users and to the nature of the very diversified tasks they may have to perform. One very recent example is related to hearing protectors. The attenuation values found at work places and with untrained subjects, reported in various reports are appreciably much lower than those measured in laboratories under standadized methods. These studies result in recommending substantial improvement of the test procedure or the introduction of significant corrections factors to the performances claimed by the manufacturers in order to make sure that the users of these equipments are effectively correctly protected. This example among others, demonstrate the need to carry out "post-normative" studies in order to validate the representativeness of the test methods used in laboratory.

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24. Noise in building – updated Polish standards

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The paper analyses the directions of changes of Polish Standards in the field of measurement and assessment of noise in building.

New measurement methods and quantities for evaluation of sound pressure levels given in standards PN EN ISO 16032 (engineering method) and PN EN ISO 10052 (survey method) are discussed. Recommendations of European Standards are compared with current acts in Poland.

The evaluation methods and permissible levels of noise in rooms, especially noise penetrating into rooms from appliances installed inside or outside of building such as fans, air-conditioners, pumps, transformers, refrigerator units, etc. proposed for updated Polish Standard PN-87/B-02151/02 are given.

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25. Attenuation of noise by motorcycle safety helmets

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Insertion loss of motorcycle helmets was measured using MIRE technique, and the sound attenuation using REAT method. Results for three Nolan helmets shows essentially no protection against external noise in frequency range below 250 Hz. In the frequency range above 500 Hz, the attenuation increases linearly at a rate of 8–9 dB per octave, to about 30 dB at a frequency of 8 kHz. Lack of attenuation in low frequency range may cause annoying effects. In addition, high attenuation in high-frequency range may decrease intelligibility of speech signals by a rider wearing the helmet. Attenuation measured in this study does not take into account noise generated by turbulent wind around a helmet. Thus, measured values of attenuation represent best motorcycle rider's conditions of hearing.

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26. The problem with assessment of acoustical climate of underground stations

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The acoustical climate problems of long enclosures concerns designing of proper acoustical environment indispensable to recognition of speech in this kind of rooms. There is some of literature concerning

the acoustic conditions of underground stations, but still there is a lack of knowledge about methods allowing the correct estimation of the reverberation conditions of this kind of enclosures.

In this paper the problem of evaluation of assessment of the reverberation condition of the underground stations is discussed. The results of reverberation time measurements in the Warsaw's underground stations are compared with calculated data.

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27. Proposed exposure criteria to prevent annoyance due to low frequency noise at workplaces

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The aim of the study was to recommend methods for assessing low frequency noise (LFN) in the occupational environment to prevent annoyance and its effects on work performance. Three different evaluating methods and corresponding admissible values were proposed: (i) method I – frequency analysis in 1/3-octave bands 10–250 Hz, (ii) method II – consisting in 1/3-octave band measurements and determination of low frequency equivalent-continuous A-weighted sound pressure level (SPL) in the frequency range 10–250 Hz, and (iii) method III – based on equivalent-continuous A-weighted SPL corrected due to the presence of low frequencies and tonal character of LFN. Separate noise limits were recommended for workplaces in the control rooms and office-like areas.

The proposed criteria were verified in the field study on subjective noise annoyance rating. The subjects, 35 male workers, employed in the industrial control rooms, aged 40.1 ± 7.2 years, exposed to LFN at A-weighted SPL of 48–61 dB, were asked to rate noise annoyance at their workplace using a 100-score graphical rating scale. Noise conditions in the control rooms were evaluated according to proposed assessment criteria. The subjective ratings of LFNs were compared to objective results from various assessing methods. The relations between annoyance and excesses of proposed limits were analyzed using Pearson correlation coefficient (r). Linear relationships between the subjective ratings and results from all proposed exposure criteria were observed ($0.550 \leq r \leq 0.673$, $p < 0.001$). However, the highest correlation coefficient was found for method II ($r = 0.673$).

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28. Theoretical predictions and actual hearing loss in workers exposed to ultrasonic noise of impulse character – a pilot study

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Ultrasonic noise is defined as a broadband noise containing high audible and low ultrasonic frequencies (from 10 kHz to 40 kHz). The so-called low frequency ultrasonic technological devices, including washers, welders, ultrasonic drills, soldering tools and galvanising pots may be quoted as main sources of ultrasonic noise in the occupational setting.

Earlier literature data suggests that ultrasonic noise exerts adverse effects on the hearing organ thus producing hearing impairment, and affects the function of the vestibular system, which is manifested by headache, nausea, dizziness and disturbed balance. The main aim of this study was to assess hearing status in workers exposed to ultrasonic noise of impulse character.

Standard pure-tone audiometry was collected from 25 workers, mainly females, aged from 23 to 58 years, exposed to ultrasonic noise emitted by ultrasonic welders during period of 2 13 years. Hearing tests were completed by evaluation of occupational exposure to audible and ultrasonic noise.

In the majority of cases (62.1%), sound pressure levels in 1/3-octave bands 10–40 kHz, occurring at workplaces, exceeded maximum intensity values (MAI) for ultrasonic noise. Similarly, sound exposure levels L_{EX}, 8h were greater than 85 dB (MAI for audible noise) in 63.3% of cases. Almost all workers declared the usage of hearing protectors. The subjects' actual audiometric hearing thresholds were compared with theoretical predictions calculated according to ISO 1999:1990 standard.

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29. Determination of acoustic fields in industrial rooms

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Problems of determination of acoustic field parameters in industrial rooms by means of testing and modelling this field with an application of geometric acoustics are presented in the paper. Next stage of the study was utilisation of inverse methods for assessment acoustic parameters of machines in industrial conditions. The development of inverse methods accompanied by the geometric methods of estimation the sound signal propagation in rooms allows to localise complex sound sources more effectively. These achievements are related to the development of calculating tools and techniques and multichannel acquisition systems of measured data.

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30. Analysis of impact of load and technical condition of noise sources on distribution of acoustic field in closed spaces

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Determination of distribution of acoustic field in space where there is a high concentration of noise emission sources of high acoustic power is difficult to make by conventional methods. It makes difficulties in a correct determination of exposure of workers to above-standard emission, as well as problems with determination of changes in field distribution in time. Parameters of sources located within the power used in manufacturing processes, e.g. of turbine sets, supplying pumps and coal pulverizers, force the necessity of reduction of noise emission.

Correct determination of acoustic field distribution for sources of high load oscillations, which operate in tough conditions which speed up degradation of technical means, is impossible without taking into account the impact of power changes and technical condition. The above mentioned tests will enable better selection of parameters of active and passive means for noise reduction, due to the use of advanced measurement methods, including intensity method and complex computational model for the whole power unit, which takes into account all technological levels of sources localization.

In previous laboratory tests and modelling, relationship between change in load and noise emission from the source was found. It was found that in case of some sources, e.g. hydro-dynamic bearings of turbine set, reduction of load results in an increase of noise emission. Tests conducted cyclically were also confirmed by continuous tests. Relationship between deterioration of technical condition and increase of noise emission was also confirmed.

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31. Acoustic modelling of machines using the inversion method for the purposes of the acoustic assessment of machines

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Issues related to the development of acoustic models of machines are important factors both in the design of low-noise machines and in the prediction of machines noise. The acoustic modelling of machines

may be carried out using a set of omni-directional substitute sound sources, located in points related to the functional elements of machines. The optimal parameters of these sources may be determined using an inversion method. To calculate these parameters by using the inversion method one must know the real distribution of sound pressure around the machine. This requires the determination, on the surface of hemisphere, of both the distribution of the amplitude of sound pressures, as well as the distribution of phase shift angles between acoustic signals. Computer simulations yield optimal parameters (sound power) for the individual omni-directional sound sources. Using the calculated parameters of the substitute sources it is possible to determine the radiation characteristics and to carry the acoustic assessment of the machine.

The results of the acoustic modelling of machines using the inversion method and computer simulations regarding the effect of the distance between the substitute sources on the emission sound pressure levels as well, as the results of the acoustic assessments of machines are presented in the paper.

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32. Noise mapping in Romania under the framework of EU directive 2002/49/EC

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The demand for environmental noise information in Romania will increase in the near future, first of all due to the integration of the country in the European Union. Some of the European Commission noise directives have already been transposed in Romanian legislation. According with this new legislation, Romania – like the EU countries – has to provide noise maps and also to prepare noise action plans with measures to reduce noise levels when limits are exceeded. The purpose is the definition of a common approach intended to avoid, prevent or reduce the harmful effects of the environmental noise.

The paper aims to present the Romanian first experience on noise mapping, during the year 2006, by respecting the requirements of European Directive 2002/49/EC. The general context is described and also specific methods for a practical case study are discussed.

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33. Reduction of the sound power radiated by a two pistons system located near the three-wall corner

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The main aim of this study is to calculate magnitudes describing the sound radiation by a system containing two vibrating circular pistons located in tree-wall corner. It is assumed that there is no influence of the surrounding medium on the sources vibrations and the vibration velocities of the pistons are time-harmonic.

Making use of the known form of the Green function valid for tree-wall corner area the formulae presenting the acoustic pressure radiated by considered sources has been obtained. In order to characterize the sound radiation of the examined system of sources the self and the mutual powers in the integral form have been also expressed. Employing the well known integral expressions the obtained formula for the self power can be presented in the form of the fast convergent sum. The investigations presented herein can be very useful for a projection systems containing some vibrating pistons. On the basis of the presented in this paper formulae the acoustic properties of the vibrating pistons embedded in tree-wall corner can be predicted. It can be very advantageous to design vibrating systems and helpful to reduce harmful noise.

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34. Measurements of exposure sound level L_{AE} generated by passing vehicles for different road surface types

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The influence of the road surface types on the noise emission level is a significant source of uncertainty of road noise maps drawn up using computational methods. In such methods the influence of the road surface type is taken into account through a correction to the noise emission level determined for the so-called reference surface. Depending on the kind of carriageway surface and its condition the road noise emission level may vary by several dB, which significantly affects the determined road noise propagation range. The paper presents the results of pass-by noise measurements for vehicles moving in the real city traffic. The investigations were carried out for 11 road with different pavements typical for city streets in Poland, including asphalt, asphalt concrete, stone mastic asphalt and cobblestones pavements. Also the results of comparative analyses of measurements and NMPB calculations for the investigated are be presented.

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35. Noise protection of Wroclaw's motorway ring-road

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The 35.4 km long stretch of motorway A8, called Wroclaw's Motorway Ring-Road (WMRR), passes through the north-west part of the city of Wroclaw and the areas of four neighbouring districts. Analyses have shown that at nighttime the extent of noise propagation at noise level $L_{\mathrm{AeqN}} = 50$ dB for the predicted traffic intensity will be 250-500 m and in 20 years it may increase by further 200 m. Eight housing estates and allotment areas within the city limits and four village housing developments will find themselves within the noise range. This means that the planned WMRR will be a new noise source in the environment, which may adversely affect large areas. The binding normative environmental protection acts mandate taking all the necessary technical and organizational measures to reduce the noise generated by the operation of WMRR in order to comply with the acoustic environment quality standards in the surrounding areas. One of the principle ways of reducing the adverse effect of road noise is to erect acoustic screens. In this case, the acoustic barriers have to be 4–10 m high. The paper will present the research methodology adopted for noise impact assessment and acoustic barriers design as well as the proposed acoustic barriers designs which take into account the acoustic requirements, the technical limitations and the urban development and architectural conditions.

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36. Noise exposure of orchestra members measurement uncertainty related to sampling

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One of the objectives in workplace noise measurement and assessment practice is to minimize the costs of testing while ensuring that its purpose is achieved, i.e. it is determined if the permissible noise exposure level has not been exceeded. Time reduction results in increased measurement uncertainty whereby the risk that it will be necessary to repeat the tests increases.

Noise exposure measurements were carried out in opera orchestra. The technique of equivalent noise level measurement in consecutive one-minute intervals, with full recording of results, was employed. Measurements were performed simultaneously on 8 workstations.

The results of the measurements were subjected to a statistical analysis in order to determine the measurement uncertainty associated with performing the measurements by sampling in time intervals of different duration.

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37. Community annoyance from aircraft-induced noise in Delhi

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Air traffic noise is a major cause of community annoyance in the residential areas near airports. The present study has been prompted by the need to examine the noise levels induced by the increased air traffic in Delhi in recent years. Noise levels have been measured in the indoor environment of two prominent residential areas of Delhi, namely, Jawaharlal Nehru University campus (UC) and Vasant Vihar (VV) which lie underneath the landing flight path of aircraft in Delhi. Spectral distributions show higher noise levels at lower frequencies and exhibit a declining trend with increase in frequency. With the help of spectral information, an index of aircraft noise, PNdB (perceived noise levels in decibels) is determined to assess relative annoyance or noisiness felt by the community of residential areas. PNdB values in the case of UC vary from a minimum of 66.7 to a maximum of 85.2. Further down the landing path, PNdB levels at VV are found to be appreciably higher in the range of 76.18–91.37.

Results of social survey conducted to assess the community response to aircraft noise reveal that a majority (73%) of the respondents experience moderate to extreme annoyance. This is in conformity with the rather high PNdB values obtained for both the residential areas.

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38. Identification ultrasonic sources based on the results of questionnaire survey

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This article presents results of measurement of ultrasonic noise at workplaces and a questionnaire survey conducted in several plants in Poland. There were results of measurement of two groups of sources of ultrasonic noise: ultrasonic technological devices and non technological devices. Technological devices are: washers' welders, ultrasonic drills, soldering tools, galvanizing pots, dental scalers, pest repellers, some textile machinery (machine for connect bugle with material, dry goods machine) etc. Non technological devices (ultrasonic noise is also generated by pneumatic tools and high-speed machinery) are: planers, millers, grinders, circular saws, some textile machinery (spinning frames, twisting machines, winders) etc. Measurement parameter was sound pressure level in the 1/3 octave band with the central frequency from 10 kHz to 100 kHz. The questionnaire survey deals with subjective identification and protection used at workplaces where hazards' noise sources occur.

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39. Localization of areas of increased vibroactivity by means of the inverse method

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Increased possibilities of parallel acquiring data and transforming them effectively together with the improvement of calculation tools made the inverse methods more important. Some examples of research,

carried out by the author, during, which the possibilities of localization of increased vibroactivity areas were studied using the multi-microphone method, are presented in the paper.

The theoretical basis of the inversion method of sound sources localization and certain laboratory test results are also given.

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40. Sound and noise levels inside UoS lecture halls

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Estimations of the sound levels and reverberation times for different premises at the University of Sharjah(UoS), United Arab Emirates(UAE), revealed the imprtance of building interiors to reduce the noise levels and improve the aural preciption inside lecture halls and other locations. Aural perception involves the ability of the human ear to distinguish between sounds with close frequency and loudness. The principles of physics of sound in architectural acoustics could reveal the distortion of sound in such buildings and highlight a solution to the problem. Furthermore, understanding architectural acoustics could lead to the best solution for the echo or sound reverberation, sound distortion and sound pollution problem aiming to provide satisfaction or noise free building. There will will be suggestions for some acoustic materials that can be used to reduce this problem such as Ecophon panels, Acousto or Armstrong panels, soft furniture, special floor covers, and foamed or cotton based covers. Therefore, a solution to the problem which related to knowledge of several acoustic tasks in different catagury of lecture halls with various architectural acoustic designs will be suggested.

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41. Noise and vibration control of a mechanical systems using nonlinear rheological fluid model.

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Rheological fluids (RF) also known as controllable viscosity fluids (CVF) are used in design of sound barriers to control sound transmission loss. Introduction of these fluids in the area of vibration control of mechanical systems made possible a more efficient control of both transient and continuous vibrations. Early applications of the common Bingham's plastic model of viscosity have not adequately described the apparent viscosity changes when external field is applied; therefore, a new model was developed. In this model the shear stress as a product of apparent viscosity, applied external field strength and relative velocity gradient demonstrates a nonlinear character. Changes in apparent viscosity affect the damping property in vibrating systems, thus the behavior of mechanical vibrating system can be controlled by a passive, variable and controllable damping force or torque. The described model was used to analyze the vibration control of linear and torsional untuned vibration absorbers with a field controllable fluid.

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42. Test stands and measurement method of vibration energy in human hand-arm system

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Two test stands for measurement Vibration Energy in human hand-arm system has been presented in this paper. First one is the stationary test stand used for laboratory measurement and second one is designed

for in situ measurement during operating hand held or guided tools. Method for evaluating the Vibration Energy Absorption (VEA) and Vibration Energy Stored (VES) in the human hand was also presented. Quantities VEA and VES are calculated from respectively real and imaginary part of the force-velocity cross-spectrum. These measurements are performed in a function of frequency and time, in which amplitude of the test signal is changing continuously. These test stands and measurement method are designed for determine relationship between VEA and quantities describing exposition to single shocks (strikes), repeated shocks and vibration (like velocity, acceleration, "jerk") and other quantities (like operators weight, size of the hand, push force, hand position).

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43. Sound absorption properties of Helmholtz resonators of perforated double plates inlet necks modified by geometrical configuration variations

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Since several years acoustical properties (acoustical impedance and absorption coefficient) of Helmholtz resonators of special design of their inlet necks as two parallel plates having orifices were examined for many variations of their geometrical parameters like the distance between the plates, diameters of the orifices and their mutual relations, mutual distribution of the orifices in both plates etc. In this paper a summing up of experimental results will be presented showing some critical geometrical parameters of the resonator necks (of double plates with orifices) important for controlling resonator properties to get optimal sound absorption characteristics in required frequency range. Some formulas for calculating the acoustical parameters for such resonators are proposed. As an example a comparison between calculation and experimental results for selected configuration is presented.

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44. Impact of weather conditions on the sound levels – pilot tests

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The investigations of influence of atmospheric conditions on noise level in receiving point were conducted in years 2003 – 2006 in Environmental Noise Division of Institute of Environmental Protection. Therefore a monitoring station, which assembles simultaneously meteorological and acoustic data was used. The measurements were executed in a larger distance than 100 m from road on height 4 m.

The practical application of long-term indicators requires addressing of, at least, two issues from environmental acoustics field:

- evaluation of the impact of various weather conditions on the sound propagation ranges,
- application of meteorological statistics – in the context of long-term averaging and with reference to sound propagation – appropriate statistics selected on acoustic grounds.

The results of these analyses' were introduced below:

1. During tests in urban areas it was not confirmed that in favourable conditions for the propagation of acoustic waves the recorded sound levels were higher than the average. Such correlation was not found either for the homogenous and unfavourable conditions.
2. When testing the impact of weather conditions on measured sound levels no direct correlation between ambient temperatures and sound level was found out. However, high daily temperature varia-

tions favour low sound level measured, and small differences between temperatures measured favour high sound levels measured.
3. No correlation between humidity and sound propagation conditions was discovered.
4. At high values of atmospheric pressure low sound levels are recorded. High pressure can be connected with clear weather, which would indicate a relationship between cloud cover and sound propagation conditions.
5. The highest impact on the sound levels measured, especially in the evenings and at night-time, has the combination of wind direction and speed. For high and medium sound level measurements the predominant winds include winds blowing towards point of reception, whereas for low sound levels – the opposite wind predominates.
6. On the grounds of carried out analyses a conclusion can be drawn that low sound levels measured occur when there are weak opposite and perpendicular winds (above 60% of cases at daytime, and above 70% of cases at night-time, above 80% in the evenings). The sound levels measured are, on average, by 4 dB lower than sound levels measured under homogenous conditions.
7. For high and medium sound levels measured the predominant winds include both strong and weak winds blowing towards the point of reception. However, the statistics for wind categories is similar in both cases. Consequently in this phase of research it is not possible to determine unequivocally when there are homogeneous and when there are favourable conditions. The research should be continued, widening the scope of measurements and tests of temperature gradient, which is known to have impact on sound propagation.

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45. Interactive web tool for awareness rising regarding exposure to noise

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Ministry of Labour, Family and Social Affairs of the Republic of Slovenia has prepared a tool which is designed for broader awareness rising regarding exposure to noise. This tool is designed for non-experts, for common blue collar workers and people that do not have great knowledge regarding noise, physical characteristics of noise etc. This tool and the contents should be understandable for people that finished primary school education.

Interactive Web tool is composed in a way that on the first page there is a house where different activities are going on, for instance kindergarten, music school, bar, joiner's workshop, noise measuring activities etc. In the background there is a silhouette of a person, a pantomimist, who is guiding the user of this tool through different activities and topics regarding harmful exposure to noise. Topics relate to different information about noise, workplace hazards, definitions of physical characteristics of noise that are important, interactive noise meter etc.

Ministry of Labour, Family and Social Affairs tried to make this tool as interesting and popular as possible. A pantomimist has been used because of several benefits, such as relating texts to physical action and positioning, motivation to interpret and understand texts, and last but not least, because we tried to present the noise with something quite opposite, "silent presentation", to gain more powerful effect.

The above mentioned tool can be seen and used on the web page: http://et2005.mddsz.gov.si/

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46. Acoustic energy distribution in space around the pipe outlet

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Visualization system, by serving a dual role as a provider of exploration and exposition capabilities, have became indispensable to the analysis of *computational fluid dynamics* (CFD) results. In the acoustical

practice, up until the last two decades, the study of vectors acoustic fields and noise flow visualisation are rather seldom. But direct measurement of the flow intensity sound as the energetic fields and graphically description of the results, can explain a diffraction and scattering phenomena occur on the real noise sources and solved in practical way a lot of engineering problems. Based on the research with intensity technique and using selected visualizations methods, in the publication are demonstrate in graphical form the sound intensity effects in the space around outlet region of cylindrical pipe. The duct model have a partly square and barrel shaped cross-section. The outlet research space was scanning with intensity probe measured the x, y and z components of sound intensity vector. Direct measurement of the acoustic power flow around outlet can explain all diffraction and scattering phenomena occur in this region and the noise generated by inside flow and around outlet of duct is an environmental concern in engineering practice.

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47. Problems of all-weather microphones calibrations in real free-field conditions

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A demand for all-weather microphones is recently on the rise due to an increasing number of monitoring stations of environmental noises (mainly air-port and traffic noises). Different types of such microphones are being designed and constructed – also by the Polish producers. Calibration of all-weather microphones in a free-field is the topic of the presentation. An acoustic calibration, regardless of simple assumptions, is difficult and time-consuming in real conditions of an acoustic field. The technical realisation of idealised theoretical requirements, demands – among others – a proper placement of devices in an acoustic space, their extremely accurate positioning and providing repeatable measurement conditions. Problems related to assuring the proper calibration accuracy in real conditions of anechoic room are presented in the paper. Certain technical solutions applied in the calibration, being the result of several years of experimenting and eliminating – step by step – factors introducing errors, are described.

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48. Hearing loss in workers exposed to noise, organic solvents and hand-arm vibration

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Occupational noise-induced hearing loss could be significantly influence by the type of noise (continuous vs. impulsive), co-exposure to vibration and chemicals like organic solvents. The main aim of the study was to evaluate hearing impairment in four groups of workers: 113 dock-yard workers co-exposed to continuous steady-state noise and organic solvent mixture; 62 dockyard workers co-exposed to impulsive noise and vibrations; 86 glass factory workers exposed to continuous steady-state noise above admissible level and 110 control subjects exposed neither to noise nor solvents. Gender and age were account as confounding factors in analyses. Audiometric results revealed the highest hearing impairment in group exposed to impulsive noise and vibration, lesser degree of hearing loss were seen in group exposed to continuous steady-state noise + organic solvent mixture, than in group exposed to continuous steady-state noise only. No changes were seen between groups in ABR test. The P-300 latency was not prolonged in noise and solvent exposed workers and steady-state noise exposed as compared to control group, but unexpectedly it was prolonged in impulse noise-exposed group suggesting a cortical effect of the exposure. This suggestion is confirmed by interrupted speech test in which we can see higher percentage of abnormal results in impulse noise group. The results indicate that noise characteristics and co-exposure to noise and

vibration or chemicals should be taken into account in the evaluation of occupational hearing loss. Results suggesting central (cortical) abnormalities require more research in the future.

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49. The influence of a vibrating rectangular piston on the acoustic power radiated by a rectangular plate

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The equation of motion of a flat simply supported rectangular plate has been solved. The plate has been excited by a surface force. The influence of the acoustic pressure radiated by the plate on its vibrations has been included. The corresponding sound pressure distributions have been presented as their backward Fourier transforms. The acoustic active and reactive sound power has been computed including the influence of the sound pressure radiated by the piston. The acoustic mutual sound power of both sources has also been presented.

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