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STUDY OF THE ENVIRONMENTAL NOISE POLLUTION IN PRODUCTION ECONOMICAL ACTIVITIES

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The paper presents results of a study of the environmental noise pollution in sewing and metal working manufacture and the harvester in agriculture. Indiscrete method for noise measurements were created. They are characterized by high precision, wide range of determination of the noise and large sample size of measured values. A probabilistic method for noise pollution assessment is introduced. Seven groups of indicators were used. The method is approbated in practice. The results show large coverage and accuracy.

Keywords: *noise, pollution, production, economics, action, assessment.*

INTRODUCTION

Risk assessment of industrial noise requires precise characterization of pollutions in the occupational environmental systems. For this purpose an indiscrete method for noise imissions measurements and probabilistic methods for evaluation were created.

The assessment of environmental noise requires accurate determination of emissions and imission control. The reason is in the complex mathematical algorithms to assess risk, requiring precise information obtained in the measurement noise. The time of occurrence of sudden changes are with the order of milliseconds to seconds. Therefore, to analyze and evaluate the noise objectively it is necessary to use appropriate measurement method and the results to be processed in a way that takes into account the random nature of unexpected change. This necessitates the need to implement indiscrete methods for analysis and risk assessment [4]. Up to now, the methods used to measure noise are characterized by a large dispersion and significant time consumption that limits their field of application beyond the needs of information provision in the risk of environmental noise.

The purpose of this work is to establish an environmental noise pollution in sewing and metal working manufacture and the harvester in agriculture. The study allow solving three main tasks:

- 1) virtual device for indiscrete noise measurement creation;
- 2) determination of the criteria for analysis and evaluation of noise pollution;
- 3) experimental study, methods testing and their capabilities analysis.

METHODS

To solve the first problem a device was used to collect data – NI DAQ 6210 [2,3,4]. It was adapted to the program LabView 8.5. DAQ 6210 and connects to the computer platform. A virtual instrument for measuring noise that comes completed to an analog sound level meter SL 401, is connected to the device input – a1. From the Start menu in Windows it is selected All programs/National Instruments LabView 8.5. A dialog box opens. It starts Blank VI, representing the workspace, which includes measuring modules. In the block diagram of the window where are elements that are necessary for programming. A dropdown menu of the program functions is activated. Input instruments are chosen and DAQ assistant for unit control. The parameters of the device, the number of measurements and the frequency of the reported measurement results are adjusted. The system is calibrated. This is done using the drop-down menu. DAQ device allows operation at 250 kS/s. In practice it is necessary to use much lower frequency. A module converting the measurement of volts (V) in relative units – decibels (dB) was developed. It is done using mathematical module Formula. For this purpose DAQ device is set to the frequency 250 kS/s. This yields a maximum amount of data in one period of oscillation of the membrane of the acoustic calibrator Robotron 05 000. It also generates a reference signal with a frequency of 1000 Hz and amplitude 94 dB. Since the length of the period was 0,001 s, then at the selected frequency, the number of measurements can be arbitrary, but more than 250. With a recording block the measured values are saved in a text file. To determine the voltage that occurs when the support sound pressure is assumed a linear relationship between the pressure in Pascals (Pa) and voltage in volts (V) is adopted. Voltage corresponding to a threshold pressure value was obtained 0,000000527 V. From the drop down menu and the tools Signal analysis is activated the module Filter. Select – a broadband filter. The lower and upper cut-off frequency must be determined. The lower frequency 500 Hz is chosen and the upper – from 5000 to 10000 Hz simulating the A-weighted SPL, which is embedded in the sound-level meter standard IEC 651. Select type of Chebyshev FIR filter with exponent of 1. The input filter is connected to the output of the module Filter, and the filter – to the output of the modules for registration and visualization of the results.

LabView 8.5 offers extensive opportunities for monitoring and analysis of data at each stage of a study of noise pollution control. The front panel contains the graphic indicators. In the block diagram is made the monitor of the output of the filter. Thus, it can be observed the values of sound pressure level in real time. The range of the scale can be adjusted to introduce additional lines to set the accuracy of the readings, to choosing between logarithmic and linear scale and to carry out a number of other ancillary operations. The data recording uses the module Write to

measurement file. It records the data directly into ".lmv" file which is supported in Excell. It is possible to set the parameters of the file and the behavior program in duplicate files. In the survey it was selected the text file format ".lmv" with one column, and if there are more than one file, the program selects the next file name and file number by turns. On the front panel Buttons pallets was selected. There is Push button. It connects to the input of the module Enable for data recording. Different values of magnitudes can be shown. With the module Amplitude and level measurements, connected to the output of the correction filter, the program calculates real-time averaged levels, the total noise level, the rms value and the maximum value of the current measurement. By connecting the outputs of the module to the appropriate text indicators this measuring values can be displayed and saved in a text file. The unit for measuring the overall level of noise is added to the module Spectral measurements. It performs FFT transformations of the signal. This module was selected. Its input is connected to the device for data collection. The values obtained are in volts. The signal to recording and display modules is calculated numerically. It helps the values of the signal to be presented in dB. A benchmark is chosen to be 1000 000, which is multiplied by the received signal after the conversion. Divisor of 0,045 serves to achieve the reference value of the used acoustic calibrator. The possibilities of the virtual instrument are advanced through the creation of an octave filter. Filter settings are inserted IRR filter type Butterworth, who has exponent 40. The lower cut-off frequency is chosen to coincide with the theoretical lower frequency of the octave. The upper frequency corresponds to the upper limit frequency of the octave. The filtered signal is fed to the computing module Amplitude and level measurements, which calculates the RMS signal after filtering. This module connects to the Formula. In the dialog box of the block it was introduced to the above. The effective average sound pressure level in octave is obtained. To cover all octaves the described scheme is replicated 8 times.

For visualization of the results signals are combined in Merge block signals. It has 8 inputs. The output module is associated with a Table. On the front panel the table appears with drop-down menu and it is set to 9 columns and 2 rows. It is able to set the accuracy of results, the size of the table, fonts and etc. To record the data of an octave, the measurement unit is connected to the data recording module.

The described virtual instrument is applied for measurements and analyzing of the imission noise. Individual measurements are carried out according to private standards. Once you have determined the measurement points according to these standards and the requirements for the measurement, the outputs of the sound level meter, installed at the measurement points, are connected to the DAQ NI 6210. Following the directories Start> All programs> National instruments LabView 8.5 and the File> Open> file name extension ".vi", started the virtual instrument. It is necessary to make an adjustment of the measurement, sampling rate and number of

values. It is made by the module DAQ assistant. Sampling frequency determines the number of values, which account for 1 s. By selecting a higher value more data are generating. In the investigations of noise pollution is selected sample rate of 10 kHz, which sets the upper limit frequency of the spectrum – 5 kHz. With a value of 20,000 the number of measurements of total noise level, the program creates a measurement cycle of 2 s, in which period the values are generated in the field. Values that define the spectrum are 10000. Before beginning the test buttons located below displays of the block diagram corresponding to the measurement of the overall sound level correction curve A and the measurement of sound pressure level at different frequencies in different octaves must be turned on. LEDs indicator change its colour. This means that it can be done continuous recording of data in a text file with the extension ".lmv". Two files for both measurements are recorded. By switching the module Write to measurement file it will be indicated the place where your files are stored the files and the name of the first file. The next generated files will be saved in the same folder with the same name and add to it in the next indication. A bookmark – Use next available filename is made. In the toolbar in must be activated Run, which is graphically recorded as a single arrow.

The system makes a measurement on set of the parameters and records a sum of two files-one with the data of measurements of the overall noise level, where is recorded and the values – RMS, Mean and Peak of the diagram displayed on the monitor, and one with different frequencies and octaves.

Working on the second and the third tasks a definition of the criteria for analysis and assessment of environmental noise and implementation of an experimental investigation is implemented. They are applied in the experimental study of noise emission from tree objects- sewing manufacture, metal working manufacture and the acriculture during harvest with rotary combine machine. The choice of the object to study is made on the basis of its popularity as a source of noise pollution of the environment. In the research is essential the selection of measuring point. As shown in some of our research, choosing the measurement point influence significantly on the analysis and evaluation of noise and can be heavily influenced results obtained [6]. In making indiscrete measurements, the location and the number of measurement points are chosen according to the Bulgarian state standard. Pollution immission characteristics are based on standards EN ISO 11201:1995 [1] and EN ISO 11204:1995 + AC 1997 [2]. The emission characteristics are determined on the basis of ISO 1999:2004 [3]. To analyze accurately the results of measurements of noise pollution in sewing, metal working manufacture and agriculture the procedure is adopted to a system of characteristics. It includes:

Group I. Distribution laws of the measured values of imissions.

Group II. Mean values: Im_{sr}, dBA – averaged A-weighted level of the sound pressure of imissions: Im_{srmin} – minimal mean value A-weighted level of the sound

pressure of imissions; $Im_{sr\ max}$ – the maximum mean value of A-weighted level of the sound pressure of imissions; $\Delta Im_{sr} = Im_{sr\ max} - Im_{sr\ min}, dBA$ – range the mean values of A-weighted level of the sound pressure of imissions;

Group III. Standard deviation: $\sigma_{Im_{min}}$ -minimum value of the deviation from the mean value of the imission; $\sigma_{Im_{max}}$ -maximum deviation of the imission values;

Group IV. Variance: $\sigma_{Im_{min}}$ minimum-value of the variance of noise imissions; $\sigma_{Im_{max}}^2$ – maximum value of the variance of noise imissions; $\Delta\sigma_{Im_{max}}^2 = \sigma_{Im_{max}}^2 - \sigma_{Im_{min}}^2$ – maximum range of the variance of noise imissions;

Group V. Amplitude: Im_{min}, dBA – the minimum amplitude of the A-weighted sound pressure level of noise imissions; Im_{max}, dBA – maximum amplitude of the A-weighted sound pressure level of noise imissions; $\Delta Im = Im_{max} - Im_{min}, dBA$ – maximum range of the amplitude in all imissions measurements; Group VI. Coefficient of variation of the mean values: $K_v[Em]_{min} / K_v[Im]_{min}$ – minimum value of the coefficient of variation for imissions; $K_v[Em]_{max} / K_v[Im]_{max}$ – maximum value of the coefficient; $\Delta K_v[Im]_{max} = K_v[Im]_{max} - K_v[Im]_{min}$ - highest range of the coefficient of variation within the all imissions measurements; Group VII. Number of exceedings: $N_{Im_{pr\ max}}$ - maximum value of rated A-weighted sound pressure level of noise imissions; $T_{Im_{pr\ max}}, s$ – the maximum time of exceeding the rated A-weighted sound pressure imission level. The program *Risk 4.5* is used for the first group parameters determination. It checks 16 law types of distribution of discontinuous and continuous random variables. Distribution laws are ranked systematically. The first law in the range is acquired. The law parameters are determined.

RESULTS AND DISCUSSIONS

Experimental studies have been made in tailoring workshop "Heros" in Ruse and metal working manufacture in the University of Ruse There were 100 attempts measured at three points. In any attempt the program software registers 20 000 measurements at three sampling rates: I- $f_s = 10\ kHz$; II – $f_s = 15\ kHz$; III – $f_s = 20\ kHz$. The measurement time of each record is determined by the relationship: $t = n_s / f_s$, where f_s is the sampling rate, kHz ; n_s - number of measured values of the noise imissions. At a constant number of values for each measurement, the sample rate determines the length of the each measurement: I- $t = 2\ s$; II – $t = 1,33\ s$; III - $t = 1\ s$.

Table 1
Parameters of noise pollution in sewing manufacture (*L*-logistic distribution law;
B-Beta distribution; *W* – distribution Weibul; *N*-normal distribution)

Parameters	Measurement points								
	I1			I2			I3		
	10kHz	15kHz	20kHz	10kHz	15kHz	20kHz	10kHz	15kHz	20kHz
Distribution law, % from all the investigations in brackets	<i>L</i> (72) <i>B</i> (28)	<i>L</i> (69) <i>B</i> (30) <i>W</i> (1)	<i>L</i> (68) <i>B</i> (31) <i>W</i> (1)	<i>L</i> (65) <i>B</i> (33) <i>W</i> (2)	<i>L</i> (65) <i>B</i> (32) <i>W</i> (3)	<i>L</i> (67) <i>B</i> (32) <i>W</i> (1)	<i>L</i> (58) <i>B</i> (41) <i>W</i> (1)	<i>L</i> (61) <i>B</i> (39)	<i>L</i> (58) <i>B</i> (42)
$Im_{sr\ min}$	64.57	63.85	64.29	66.77	66.33	65.00	64.05	61.26	61.74
$Im_{sr\ max}$	71.19	74.85	73.56	77.68	77.86	75.37	68.55	70.43	70.18
$\Delta Im_{sr}, dBA$	6.63	11.01	9.27	10.91	11.54	10.38	4.51	9.17	8.45
$\sigma_{Im\ min}$	10.01	9.00	9.30	8.98	8.88	9.45	9.97	9.81	9.84
$\sigma_{Im\ max}$	10.78	10.51	10.77	10.45	10.90	11.33	10.82	10.61	10.60
$\sigma_{Im\ min}^2$	100.2	80.91	86.47	80.52	78.85	89.25	99.28	96.14	96.72
$\sigma_{Im\ max}^2$	116.21	110.29	115.81	108.95	118.65	128.36	117.03	112.54	112.29
$\Delta\sigma^2_{Im\ max}$	16.02	29.38	29.35	28.44	39.81	39.11	17.75	16.40	15.58
Im_{min}, dBA	0.02	0.01	0.02	0.05	0.01	0.04	0.01	0.02	0.01
Im_{max}, dBA	99.2	98.57	99.84	107.37	112.91	110	94.56	94.73	92.61
$\Delta Im, dBA$	99.18	98.56	99.82	107.33	112.91	109.97	94.56	94.72	92.60
$K_v [Im]_{min}$	14.07	12.15	9.61	11.56	9.52	9.66	14.79	9.20	14.33
$K_v [Im]_{max}$	16.08	16.19	16.15	15.31	15.24	15.73	16.62	16.73	16.49
$\Delta K_v [Im]$	2.01	4.05	6.55	3.76	5.73	6.07	1.83	7.54	2.16
$N_{Im\ pr\ max}$	484	942	1097	3207	3539	1642	240	249	220
$TI_{m\ pr\ max}, S$	0.05	0.07	0.06	0.33	0.24	0.09	0.03	0.02	0.02

The position and the number of measurement points are selected accordingly to the Bulgarian state standard BDS ISO 1999:2004, rejecting BDS 15204:1980, used in some stages of the work. Analyzing the results a strong influence of the measuring point's position was established. Therefore, preliminary trials and determinations of the microphone localization were made. The data analysis (Tables 1 and 2) show considerable dynamics in the results of measuring Table 2 noise in both proceedings. The laws of distribution of A-weighted sound pressure levels indicate priority distribution logistics law. In clothing production this law shall be established in 58-72% of the trials and in metal working manufacture at 65-76%. Rarely immission obey the Weibul distribution -an average of 1 to 3% for both procedures. Beta distribution is found in approximately 30-33% of the trials. Only one of the trials demonstrated a normal distribution.

Table 2

Parameters of noise imissions in metal working manufacture (*L*-logistic distribution law; *B*-Beta distribution; *W* – distribution Weibul; *N*-normal distribution)

Parameters	Measurement points								
	I1			I2			I3		
	10kHz	15kHz	20kHz	10kHz	15kHz	20kHz	10kHz	15kHz	20kHz
Distribution law, % from all the investigations in brackets	<i>L</i> (68) <i>B</i> (30) <i>W</i> (2)	<i>L</i> (70) <i>B</i> (30)	<i>L</i> (72) <i>B</i> (28)	<i>L</i> (68) <i>B</i> (30) <i>W</i> (1)	<i>L</i> (76) <i>B</i> (24)	<i>L</i> (72) <i>B</i> (26) <i>W</i> (2)	<i>L</i> (66) <i>B</i> (34)	<i>L</i> (65) <i>B</i> (31) <i>W</i> (3)	<i>L</i> (67) <i>B</i> (33)
$Im_{sr\ min}$	73.73	73.62	73.58	74.3	74.53	69.24	67.12	59.48	67.1
$Im_{sr\ max}$	80.3	95.9	78.75	88.48	84.93	84.08	70.59	70.37	71.22
$\Delta Im_{sr}, dBA$	6.57	22.28	5.17	14.19	10.41	14.85	3.47	10.9	4.12
$\sigma_{Im\ min}$	9.97	9.87	9.92	9.86	9.85	9.84	9.97	9.83	9.95
$\sigma_{Im\ max}$	11.05	13.02	10.53	12.07	10.46	11.09	11.9	14	10.43
$\sigma_{Im\ min}^2$	99.21	97.3	98.25	97.1	96.96	96.76	99.27	96.49	98.97
$\sigma_{Im\ max}^2$	121.93	169.42	110.82	145.57	109.28	122.95	141.4	196	108.65
$\Delta\sigma_{Im\ max}^2$	22.73	72.13	12.58	48.48	12.33	26.2	42.14	99.52	9.68
Im_{min}, dBA	0.12	0.04	0.02	0.01	0.01	0.02	0.02	0.01	0.03
Im_{max}, dBA	109.23	119.26	102.74	112.48	109.79	108.85	105.81	109.1	93.11
$\Delta Im, dBA$	109.12	119.23	102.73	112.48	109.79	108.84	105.8	109.1	93.08
$K_v [Im]_{min}$	9.83	12.95	12.86	12.09	9.72	12.44	14.42	9.32	9.34
$K_v [Im]_{max}$	13.25	13.38	13.69	13.14	13.63	13.06	14.83	14.84	14.55
$\Delta K_v [Im]$	3.43	0.44	0.83	1.06	3.91	0.63	0.42	5.52	5.22
$N_{Im\ pr\ max}$	7432	16073	5883	2422	11686	10616	54	2128	589
$TI_{m\ pr\ max}, s$	0.75	1.08	0.3	0.25	0.78	0.54	0.01	0.15	0.03

That is the evidence that conventional assumptions about normal distributions laws are not true, if they are not proven experimentally. Minimal average imission values $Im_{sr\ min}$ are related order – 61,74-66,72 to 66, 72 in tailoring manufacture and 59,67-74,55 *dBA* in metal working. The same is at the maximum values $Im_{sr\ max}$ of the averages. The same applies to the interval of averaged values of ΔIm_{sr} -от 4,51 to 11,32 and 7,83-12,32 *dBA*. It is interesting to see the minimal and maximal measured values and their accuracy of the determination. With the proposed method it was registered values up to 4-5 and more decimal places and values, close to zero. These values are 0,01-0,05 *dBA* in clothing manufacture which, by traditional methods of measurement can not be identified. The same ifact is watched and for the maximal values. In the sewing production maximum imission reaches 112,91, and in the metal working workshop – 119,23 *dBA*. The lowers value of the maximum range of the coefficient of variation within the trial is measured at the point I2 and sampling

rate of 15 Hz in metal working noise imissions. The values are $K_v [Im]_{max} = 55,2\%$. Naturally, the maximum range of variability is $\Delta\sigma^2_{Im_{max}} = 99,52$. These results highlight the variability in the nature of the noise because there is more concentration of machine tools in a work zone. The number of exceeding of values of A-weighted sound pressure levels in metal working manufacture is changing in a very large range, from 54 to 16073. These exceeding have such accuracy that can not be determined by the conventional methods of measurement. In sewing production the exceeding $N_{Im_{pr_{max}}}$ are less – from 220 to 3539.

Table 3
Parameters of noise emissions and imissions of combine CASE 2288 (L-logistic distribution law; B-Beta distribution)

Parameters	Emmissions			Immissions		
	10kHz	15kHz	20kHz	10kHz	15kHz	20kHz
Distribution law, % from all the investigations in brackets	L(76) B(24)	L(71) B(29)	L(67) B(33)	L(84) B(6)	L(87) B(3)	L(81) B(19)
$Em_{sr_{min}} / Im_{sr_{min}}$	89.92	89.71	89.42	72.78	72.09	72.68
$Em_{sr_{max}} / Im_{sr_{max}}$	93.07	92.28	91.97	75.67	78.35	76.9
$\Delta Em_{sr}, dBA / \Delta Im_{sr}, dBA$	3.16	2.57	2.56	2.89	6.26	4.23
$\sigma_{Em_{min}} / \sigma_{Im_{min}}$	9.9	9.94	9.93	9.86	9.75	9.6
$\sigma_{Em_{max}} / \sigma_{Im_{max}}$	10.43	10.44	10.43	10.4	10.41	10.48
$\sigma^2_{Em_{min}} / \sigma^2_{Im_{min}}$	97.94	98.68	98.49	97.13	94.92	92.06
$\sigma^2_{Em_{max}} / \sigma^2_{Im_{max}}$	108.6	108.87	108.58	108.11	108.34	109.68
$\Delta\sigma^2_{Em_{max}} / \Delta\sigma^2_{Im_{max}}$	10.67	10.2	10.1	10.99	13.43	17.62
$Em_{min}, dBA / Im_{min}, dBA$	0.11	0.06	0.01	0.01	0.05	0.01
$Em_{max}, dBA / Im_{max}, dBA$	114.36	115.57	113.3	113.29	119.09	114.82
$\Delta Em, dBA / \Delta Im, dBA$	114.25	115.52	113.29	113.29	119.05	114.82
$K_v [Em]_{min} / K_v [Im]_{min}$	10.76	10.78	10.96	13.03	12.56	12.56
$K_v [Em]_{max} / K_v [Im]_{max}$	11.14	11.31	11.25	13.83	12.83	13.46
$\Delta K_v [Em] / \Delta K_v [Im]$	0.39	0.53	0.30	0.81	0.27	0.9
$N_{Em_{pr_{max}}} / N_{Im_{pr_{max}}}$	16582	16283	16114	2571	5336	3832
$T_{Em_{pr_{max}}}, s / T_{Im_{pr_{max}}}, s$	1.66	1.09	0.81	0.26	0.36	0.2

Similarly it was obtained and the exceedings time. Values $TI_{m_{pr_{max}}}$ from 0,1-0,2 to 0,24-1,08 s were registered. The maximum single value of the amplitude of sound pressure is measured at point II of metal working manufacture at 15kHz with values between 15,15-119,15 dBA.

The object of the study is to the noise of a rotary combine harvester CASE 2388 with parameters. The emission characteristics are determined on the basis of ISO 1999:2004 [3]. During the immission measurement it is selected one measuring point

in the cab of the machine at a height $0,8m$ upon the level of the seat and $0,1m$ head away from the operator [6]. Emission tests were performed at selected points from the corpus of the machine, located away from the foundation, satisfying the condition of distance $1m$ from the body. Its axis is directed towards working bunker, which has the largest share in the emitted noise.

There were 100 attempts, made at three measurement points. In any attempt are 20,000 measurements at three sampling rates – f_s : I- $f_s = 10kHz$; II – $f_s = 15kHz$; III- $f_s = 20kHz$. At a constant number of values for each measurement, the sample rate determines the length of recording meanings: I- $t = 2s$; II – $t = 1,33s$; III - $t = 1s$. Data analysis (Table 3) shows significant results in the dynamics of measurement noise. The laws of distribution of A weighted sound pressure levels indicate priority distribution on logistics law. This law is established in 67-87% of attempts. This is a proof that conventional assumptions about normal distributions laws are not true, if are not demonstrated experimentally.

An interest is there with the minimum and maximum measured values and the accuracy of the determination. The proposed method amounts to 4-5 record and more decimal places and levels close to zero. These values are from 0.01 to 0.110, which by conventional measurement methods can not be identified. The same goes for the amount of the maximum value of the immissions, that reached $114,82 dBA$.

The lowest value of the maximum range of the coefficient of variation within the experiments in immission is observed at a sampling rate $20kHz$. It reaches values $K_v [Im]_{max} = 90\%$. The maximum range of the variance is $\Delta\sigma^2_{Im_{max}} = 17,62$. These results underscore the uneven nature of the noise.

The number of exceedings of the levels of A-weighted sound pressure levels $N_{Im_{pr_{max}}}$ vary in a very wide range, from 2571 to 16 582. These exceedings with such accuracy can not be determined by conventional method. Similar results are received and for the time of overruns $TI_{m_{pr_{max}}}$. Registered values are in the range from 0.2 to 1.66 s. The maximum single value of the amplitude of the sound pressure is measured at pollution in point at frequency $f_s = 15kHz$ – $119,0 dBA$.

CONCLUSION

We can make the following conclusions:

- 1) proposed methods for measuring and assessing of noise pollution have high accuracy, high resolution and unlimited measuring range;
- 2) introduced by seven groups of parameters they completely describe the process of pollution levels and present most accurate their dynamic evolution over the time;

3) comparisons of the features offered do not create difficulties, since all calculations are carried out numerically and the final results are tabulated. Indeed, comparing their findings is subjective. Errors cannot be admitted because the quantitative characteristics were obtained as accurate and objective indicators of pollution levels of the industrial noise;

4) the method has successfully been probated in the measurement and evaluation of noise generated in the environment of sewing and metal working manufacture and the harvester in agriculture. All calculations are carried out numerically, and the final results are tabulated, which minimizes subjective mistakes;

5) the quantitative characteristics obtained are accurate and objective indicators of environmental noise.

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