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-SUMMARY-

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ANTON DARSY

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**THE STUDY OF INDUSTRIAL AND URBAN
EQUIPMENT UNDER THE ASPECT OF THE
NOISES PRODUCED FOR THE SAFETY OF THE
ACTIVITIES**

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1. Concepts, definitions, thesis motivation, pursued objectives

The thesis "Study of industrial and urban equipment under the aspect of noises produced in order to secure activities" addresses an extremely current subject of study in the industrial era in the context of the globalization of socio-economic activities, presenting a way of applied research harmonized with the current requirements specific to the use of noise-generating equipment noise, from the perspective of the continuous improvement of the climate of safety and health at work in the work systems affected by the presence of this noise, considering the fact that their operation implies, at the level of the techniques currently used, the necessity and obligation to carry out noise measurements and determinations, for the purpose of researching the causes of their production and guaranteeing predetermined quality levels.

The theoretical and practical substantiation of the methodological infrastructure regarding the determination and evaluation of compliance with the noise generated by industrial and urban equipment, assumed the following research steps:

- Study of occupational health and safety requirements applicable at national level, harmonized with European regulations in the field of noise;
- Analysis of noise as a harmful factor for human health;
- Establishing the requirements for the competence of the testing laboratories and for the evaluation of the conformity of the noise equipment;
- Development and processing of methodological tools intended for tests to determine noise parameters;
- The development and procedure of the methodological infrastructure for evaluating the conformity of equipment regarding noise emission;
- Development of the integrated quality management system specific to noise testing and certification activities;
- Creation of a specialized IT application in the field of the integrated quality management system specific to noise testing and certification activities.

The motivation of the doctoral thesis is related, on the one hand, to the necessity and possibility of developing/adapting the methodological mechanism regarding the assessment of the risk of hearing loss, as a result of exposure to professional noise, and on the other hand, to the configuration of methodological tools of good practice in the field the noise security of the activities carried out in the presence of industrial and urban equipment, ensuring unitary guidance and guidance in the effective management of security quality based on an integrated management system of the quality of testing and noise certification.

The main objectives of the other thesis consist in the conceptualization of the mechanism for assessing the risk of hearing loss, as a result of dangerous exposure to noise in the work process, and on the other hand, in the configuration of good practice methodological tools in the field of testing and certification for noise generated by industrial and urban equipment, based on the results of the technical-scientific research undertaken. These main objectives are achieved by achieving the derived objectives, namely: the analysis of the minimum requirements for safety and health at work applicable at the national level, harmonized with the European regulations in the field of noise; evaluation of the general requirements for the competence of testing and calibration laboratories, as well as those specific to certification bodies; the development of a modern conceptual-applicative risk analysis tool; development of an integrated quality management system in the field of noise testing and certification of equipment operating in normal and/or explosive environment.

The derived objectives, in turn, are achieved by achieving the following primary objectives: the study of specialized literature by consulting the main bibliographic references in the field of interest of the thesis; defining the noise generated by industrial and urban

equipment and conceptualizing the risk of hearing loss as a result of occupational noise exposure; measuring noise and establishing general solutions to combat it; the development of the procedural methodologies regarding noise testing and certification and exemplifying how to apply them in practice (measurements/determinations of noise parameters and certifications of noise-generating equipment); designing and developing the integrated quality management system specific to noise testing and certification activities, as well as a specialized computer application in this regard.

The paper begins with the synthetic exposition of the main regulations applicable at the international and national level in the field of noise, which establish normative technical aspects regarding the effects of noise emissions, critical values and the method of protection against this physical risk factor.

The next step in the research focuses, both on the analysis of the characteristics of noise as a harmful factor for human health, as well as on the requirements for the competence of testing laboratories and for the assessment of the conformity of noise-generating equipment.

Another important step of the research lies in the expression of the contributions regarding the development and procedure of the methodological tools intended for the tests to determine the noise parameters, as well as the development and procedure of the methodological infrastructure for evaluating the conformity of the equipment regarding the noise emission, with the highlighting of the following results: procedured test methodology regarding the determination of acoustic power parameters for equipment; procedure test methodology for the determination of noise parameters in order to assess occupational exposure; results of pilot tests to determine noise parameters (acoustic power at equipment and continuous equivalent noise level).

With regard to the proper management of noise in the work process, the technical-scientific measures undertaken were aimed at both the development of the integrated quality management system specific to noise testing and certification activities, as well as the creation of a specialized computer application in this regard.

The research strategy that was the basis of the work aimed at three major directions of action in technical-scientific terms, respectively:

- The beginning of the thesis with the study of the specialized works in the field of measuring and evaluating the noise produced by industrial and urban equipment, in order to secure the activities, in order to strengthen the theoretical basis on which the theoretical-applicative premises of ensuring an effective noise management are founded, respecting the principles of quality, the evaluation of the security/safety of the technical equipment involved in the technological processes. Thus, following the interrogation of multiple databases with scientific articles, we considered for the realization of this work a number of 64 established bibliographic references;

- The second dimension of the research consisted in the conception and realization of the conceptual mechanisms for substantiating the technical-scientific instruments for assessing the risk of hearing loss in relation to the security requirements specific to the securing of noise work systems;

- The last dimension of the research consisted in the establishment of technical solutions and a specialized IT application for evaluating and managing the noise produced by industrial and urban equipment based on an integrated quality system for testing and certifying their noise security quality.

2. Structure of the thesis and some contributions

From a structural point of view, the thesis contains an introductory chapter with a specific theme and 7 chapters of content, to which is added a final chapter of Final Conclusions and personal contributions, totaling 212 pages, of which 209 pages represent the actual thesis and 3 pages it represents the Bibliography which has a number of 64 bibliographic notes and the specialized Appendices that contribute to a better understanding of the thesis and its objectives.

Among the main contributions of the author that are documented in the chapters of the doctoral thesis can be listed:

- Realization of an integrated analysis through which the national and international legislative framework was identified that allows specific activities with industrial and urban noise-generating equipment to be carried out in predictable security conditions;
- Carrying out a synthesis study which highlighted the correspondence between national and international regulations applicable in the field of noise regarding the risk of hearing loss, thus creating the premises of a particularly useful guide for economic operators active in this field, facilitating the taking optimal decisions when the integrated noise security of industrial and urban equipment is necessary based on the assessment of their conformity;
- Development of a modern conceptual-applicative tool for analysis and evaluation of the risk of hearing loss generated by dangerous exposure to occupational noise;
- Development and procedure of a test methodology regarding the determination of acoustic power parameters for equipment;
- Elaboration and procedure of a test methodology regarding the determination of noise parameters, in order to assess professional exposure;
- Synthesizing the results of the pilot tests to determine the noise parameters (acoustic power at equipment and continuous equivalent noise level);
- Practical application regarding the certification of equipment in terms of noise emission;
- Development of the integrated quality management system specific to noise testing and certification activities;
- Creation of a specialized IT application in the field of the integrated quality management system specific to noise testing and certification activities.

The valorization of the results of the undertaken research was achieved by supporting and publishing some works, in the proceedings of some conferences/symposiums or ISI or BDI indexed journals.

3. Synthesis of the paper

The continuous improvement of the climate of safety and health at work in work systems affected by the presence of noise requires, in addition to the assessment of the occupational risks generated by exposure to noise, and the solution of some problems, such as: the development of procedures regarding the noise test of equipment, as well as the determination and assessment of professional exposure to this noise; development of a certification system for equipment in terms of air noise emission; the implementation of an efficient system of training and testing of personnel regarding aspects of safety and health at work.

The study of the functioning of industrial and urban equipment implies, at the level of the current technique, the necessity and obligation of carrying out noise measurements and determinations, in order to investigate the causes of their production, as well as the evaluation of their noise compliance, in order to guarantee some quality levels from this point of view.

The doctoral thesis entitled Study of industrial and urban equipment in terms of noise produced in order to secure activities is structured in 9 chapters.

In the **first chapter**, called *"Introduction"*, the general considerations, the main objective and the specific ones, the motivation of the thesis and a brief synthesis of the work are presented.

Chapter 2, *"Study of nationally applicable occupational health and safety requirements, harmonized with European regulations in the field of noise"*, presents a synthetic exposition of the main regulations applicable at international and national level in the field of noise, with the exposition of minimum occupational safety and health requirements regarding: exposure of workers to noise in the work process; safety and/or health signaling at the workplace; workers' use of personal protective equipment at the workplace. Normative provisions regarding limiting the level of noise emissions in the environment produced by equipment intended for use outside buildings are also highlighted. In the context of an increasingly demanding legislation of economic development, of measures to intensify the increase of safety and health at work, as well as of environmental protection, of general training regarding the concern of interested parties in work efficiency, solving social and environmental objectives, of sustainable development, organizations have become increasingly concerned with obtaining and maintaining new performances by controlling the impact of activities, products and services according to the elaborated policy. Strategically, the issue of noise is addressed unitarily at the national level in accordance with European practice in the field, through the progressive implementation of the regulations and techniques already used in the EU member states, regarding the monitoring of noise emission levels, the creation of noise maps to ensure safety and health the population and the quality of the environment because noise emissions have destructive effects, affecting human health and behavior, as well as the environment. The harmonized national legislation in the field regulates the aspects regarding the effects of noise emissions, the critical values and the method of protection against this physical risk factor.

Chapter 3 is called *"Contributions on the Analysis of Noise as a harmful factor to human health"*. In this chapter, data and information are highlighted regarding: the physical and physiological characteristics of noise necessary for the conceptualization and assessment of the degree of damage to auditory health as a result of dangerous exposure to this noise; measuring/determining professional noise and establishing general technical solutions to combat it; the evaluation of the technical/technological system, in order to analyze the risk management process with the highlighting of continuous improvement solutions in the field of risk management, as well as the development of a modern conceptual-applicative tool for the analysis and evaluation of the risk of hearing loss generated by dangerous exposure to noise professional. From a technical point of view, this tool expresses a way of quantifying the phenomenon of the manifestation of the dangers specific to noisy work processes that generate professional risks with impact, both on the human component from the perspective of hearing impairment, and on the level of the other component elements specific to the systems of work through the effect of masking possible malfunctions produced at the level of technical equipment. People regularly exposed to dangerous levels of noise can reach hearing loss of variable severity, which generates deterioration in the understanding of speech and the perception of acoustic signals produced in the work process or those dailies. Except for exposure to the effects generated by explosion-type phenomena, to high impulse noise, as well as to extremely high levels of stationary noise, permanent damage to the auditory organ can be achieved over time, being progressive depending on the period of exposure.

In **chapter 4**, called *"Establishing the requirements for the competence of testing laboratories and for evaluating the conformity of equipment regarding noise"*, a series of theoretical contributions are presented on the establishment of both the general requirements

for the competence of testing and calibration laboratories in the field of noise, distinctly pointing out the aspects of order technical and management related, as well as the specific requirements for the conformity assessment of noisy equipment, with an emphasis on noise level limitation and conformity assessment procedures in terms of noise emission. Industrial activity carried out in the presence of risks generated by noise exposure was and remains a dangerous work process due to the effects on the health and safety of workers. Considering the nature of the work equipment, the problems that have arisen at the social level, as well as the changes generated by technical progress, for the sustainable assurance of the work process in predetermined safety and health conditions, it is absolutely necessary to know and master the legislative requirements applicable at the national level which have been harmonized with the European Union and international legislation in the field.

In order to continuously improve the climate of safety and health at work in the work systems affected by the presence of noise, the attention of the factors involved and responsible in the field is constantly directed towards solving the following problems: the development of practical and coherent methods for assessing occupational risks generated by exposure to noise, their monitoring and the performance of security audits, as well as the investigation and analysis of work accidents and occupational diseases caused by this type of physical nuisance; creation of a certification system for equipment in terms of noise emission in the air; the development of procedures regarding the noise test of equipment, as well as the determination and evaluation of professional exposure to this noise; the implementation of an efficient system of training and testing of personnel regarding aspects of safety and health at work.

The study of the operation of the equipment implies, at the level of the current technique, the necessity and obligation to carry out noise measurements and determinations, in order to investigate the causes of their production, as well as for the purpose of their certification, in order to guarantee some quality levels from this point of view.

The aspects related to *"Contributions regarding the development and processing of methodological instruments intended for tests for the determination of noise parameters"* are highlighted in **chapter 5**, it presents at a synthetic level the methodological test infrastructure processed, both for the determination of the acoustic power parameters of equipment, and for the assessment of professional exposure to noise, also highlighting a series of representative results obtained after conducting pilot tests.

In **chapter 6** entitled *"Contributions regarding the development and procedure of the methodological infrastructure for evaluating the conformity of equipment regarding noise emission"*, a section is presented dedicated to summarizing the specific procedures for evaluating the conformity of noise-generating equipment, related to: initiating the certification of equipment from the point of view of noise emission; evaluation of documentation; taking samples for initial tests; audit of testing laboratories; auditing and evaluation at the manufacturer; internal production control completed with the evaluation of technical documentation and periodic verification; product unit verification; control of equipment subject to noise level marking. Also, a practical application regarding the certification of equipment in terms of noise emission is presented with the example of the certification for limiting the level of noise emissions in the environment for the CA-14 felling hammer.

Chapter 7 - *"Contributions to the development of the integrated quality management system specific to the noise testing and certification activities"*, summarizes the system documents specific to the acoustic power testing and certification activities of the equipment, which were developed in compliance with the quality principles, respectively: the integrated manual of quality for noise testing and certification; general integrated procedure for noise testing and certification; integrated system procedure for noise testing and certification; integrated section of the organization and operation regulations of the noise conformity assessment body.

The integrated quality manual MC-01_(LIZ-OECZ) presents the quality policy and objectives, both in the field of specific LIZ noise tests, and in the evaluation activity of product suppliers in the field of competence of the OECZ, as they are formulated by managements of LIZ and OECZ.

The general integrated procedure PG-01_(LIZ-OECZ) has as its object the description of the way of elaboration, approval and revision of the documents of the integrated quality system within the LIZ Noise Testing Laboratory and the OECZ Noise Conformity Evaluation Body.

The integrated quality system related to the LIZ Noise Testing Laboratory and the OECZ Noise Conformity Assessment Body includes 13 specific integrated system procedures, both for testing and for certification.

According to the Regulation on the organization and operation of the commission for handling appeals RCTC_OECZ, the Commission for Handling Appeals has as its object of activity the analysis and resolution of appeals to OECZ decisions received from certificate applicants.

The regulation on the organization and operation of the Noise Conformity Assessment Body_ROF-1_OECZ is intended to establish the specific elements of the operation of the OECZ, with reference to the organization of the certification activity.

According to the Regulation on the organization and operation of the Steering Committee of the Noise Conformity Assessment Body_ROF-2_OECZ, the management of the OECZ Noise Conformity Assessment Body is ensured by the Steering Committee, which is responsible for carrying out certification by the OECZ.

The regulation of the technical working groups within the Organization for the Evaluation of Noise Conformity_ROF-3_OECZ establishes the rules that refer to the way of constitution, organization and functioning of the Technical Working Groups of the OECZ within the structure of the Organization for the Evaluation of Noise Conformity.

In **Chapter 8** - *"Contributions to the creation of a specialized computer application in the field of the integrated quality management system specific to noise testing and certification activities"*, I presented the computer application AQNOISE.EXE 01, which is a work tool used for the operative and procedural management of the documents related to the integrated quality management system specific to noise testing and certification activities by entering data and information related to: legal regulations that are applicable, both in the field of testing and evaluating the compliance of noise equipment; noise testing and certification objectives and policies; purpose and scope of use; duties and responsibilities in the field of noise testing and certification; implementing, maintaining and improving the integrated quality system in the field of noise testing and certification; ways of action and information flows; ways of recording data, in order to ensure compliance with the applicable requirements in the field of noise testing and certification.

Chapter 9 entitled *"Final conclusions and personal contributions"* highlights the contributions made to the study of industrial and urban noise-generating equipment from the point of view of securing the activities carried out in their presence, both in terms of the configuration of a modern conceptual-applicative analysis and evaluation tool of the risk of hearing loss generated by dangerous exposure to professional noise, as well as through the development of the methodological infrastructure for determining and evaluating compliance with noise, along with the way of implementing and capitalizing on the results of research undertaken at the current level and in the future.

4. Personal contributions

4.1.-Theoretical contributions

The main theoretical contributions with significant technical-scientific impact, derived from the doctoral thesis, are:

- Carrying out an integrated analysis through which the national and international legislative framework was identified that allows specific activities, with noisy industrial and urban equipment, to be carried out under predictable noise security conditions;
- Carrying out a synthesis study which highlighted the correspondence between the applicable national and international regulations in the field of noise regarding the risk of hearing loss and noise compliance of industrial and urban equipment, thus creating the premises for the creation of a particularly useful guide for economic operators with activity in this field, facilitating optimal decision-making when the integrated security of these technical facilities is necessary;
- The development of a modern conceptual-applicative tool for the analysis and assessment of the risk of hearing loss generated by dangerous exposure to occupational noise;
- Establishing general and specific requirements for the competence of testing laboratories and for evaluating the conformity of noise equipment;
- Development and processing of methodological tools intended for tests to determine noise parameters (acoustic power of equipment and noise parameters, for the evaluation of professional exposure at the workplace);
- The development and procedure of the methodological infrastructure for evaluating the conformity of equipment regarding noise emission (specific procedures regarding: initiating the certification of equipment from the point of view of noise emission; evaluation of documentation; taking samples for initial tests; auditing of testing laboratories; auditing and evaluation at manufacturer; internal production control completed with evaluation of technical documentation and periodic verification; product unit verification; control of equipment subject to noise level marking.

4.2.-Contributions in the field of applied IT

- Specialized IT application AQNOISE.EXE 01 specific to the integrated quality management system of noise testing and certification activities.

4.3.-Experimental and applied contributions

The main experimental and applied contributions with significant technical-scientific impact derived from the doctoral thesis are:

- Pilot tests carried out according to the reference documents HG 1756/2006, SR EN ISO 3744, based on the test procedure PI-01 and the work instruction IL-01 for determining the acoustic power parameters of equipment (lawn mowers type STHIL FS 300, mobile welding generator type Gesan GS 170 ACH with key start -5kVA, mobile waste container 120 l, portable picamer type slaughter hammer CA 14 and perforator type P 90);
- Pilot tests carried out according to the applicable technical requirements of Law 319/2006, HG 493/2006 and HG 601/2007, as well as the methodological requirements specified in SR ISO 1999, based on the PI-02 test procedure and the IL work instruction -02 for the determination of the noise parameters, in order to evaluate the professional exposure at the workplaces (Typing - EM Lupeni, Telegravimetric Station - EM Lupeni and Ventilation Station - EM Lupeni);
- Example of noise certification of CA 14 hammer type equipment (Examination report on compliance with security requirements of equipment intended for use outside buildings no. 001/17.07.2021; Certificate of conformity no. OECZ-01/1/19.09 .2021X;

Certification report of equipment intended for use outside buildings no.01/19.06.2021;
Quality assurance notice no.OECZ.Q.2021()12...; EC certificate of conformity).

4.4.-Future research directions

Taking into account the contributions expressed in the paper and the research problem identified, the following research directions with the possibility of future approach can be highlighted:

- Conception and configuration of noise test procedures and methodologies within schemes for inter-laboratory tests and their implementation within the integrated quality system;
- Elaboration of documentation for the accreditation of the noise test laboratory and the noise conformity assessment body and their implementation within the integrated quality system;
- Digitization of the modern conceptual-applicative tool for analysis and evaluation of the risk of hearing loss generated by dangerous exposure to occupational noise;
- Research on the creation of an intelligent industrial space equipped with state-of-the-art IT devices and specialized IT applications intended for remote monitoring of professional noise.