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STRATEGIC DIRECTIONS IN IMPLEMENTATION OF ENVIRONMENTAL NOISE DIRECTIVE IN INTERNATIONAL AND NATIONAL LEGISLATION

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Abstract. *Until 1996, the noise policy in Europe had concentrated on the regulations of noise emission from noise sources as road traffic, aircraft and equipment used outdoors. Although noise limits have become increasingly stringent over the years, no corresponding significant reduction in noise emission has been observed. In response to this, the European noise policy has been revised to focus on noise reception. Thus, the Green Paper from 1996 defines as the basic aim of future noise policy that "no person should be exposed to noise levels which endanger health and quality of life". The structure of a new future noise policy has to be based on the Directive on the Assessment and Management of Environmental Noise, 2002/43/EC. The Directive defines the three key elements: assessment of environmental noise through strategic noise mapping, implementation of action plans to reduce noise where necessary and information for the public about noise levels and its effects. The Directive defines the common noise indicators and methods for strategic noise mapping as well as the deadline for the Directive implementation. The Directive implementation at national and local level means enacting the new acts or amending existing acts. In this paper, the proposal of steps that can be taken for harmonization of national acts with the basic principles and elements of the Directive is presented and discussed.*

Key words: *noise, management, noise indicators*

INTRODUCTION

The planet Earth was reined by the big calm for millions of years. Silence was merely disturbed by thunder, shriek of the winds, animal roar and, since recently – since two million years ago – by the semi-articulated speech of the humanoid creatures. To maintain the balance, nature gave humans one tongue and two ears so they could hear twice better than they could speak.

In a brief historic period of 5-6 centuries, stone tool workshops, millhouses, blacksmiths, cars, planes and other sources of pollution rose permanently. In the mid-19th century the relay race of the technological revolutions started in full sprint to defy the serenity of the

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centuries. Man finds himself with no quietness in his environment. Noise haunts him at his working place, in the house, on the street, in the restaurant, everywhere and always, day and night. What is noise, actually? Noise is a disturbing, annoying sound that harms the physical and psycho-physiological functions of the human organism. In the narrow sense, noise is just a subjective experience of a physical occurrence. Realistically, a sound becomes a noise only in the presence of a human or an animal that is disturbed by one.

The result of the acoustic energy growth is a trauma, lesion to and neurosis of the extra-auditory etiology, concomitant with the research challenges of the scientific public from the domain of medical, legal, engineering, socio-psychological, economic, and other sciences organized in an interdisciplinary corpus for acoustic aggression protection.

Billions of Earth's human population under the burden of decibel's shackles, submissive to the addiction of consummation of fruits of technological revolutions, yearns for the tranquilizing therapy of the engineering practice.

EVOLUTION OF THE EUROPEAN REALITY

One of the serious social problems is environmental noise. In the European Union, about 80 million people suffer from noise levels that are considered to be unacceptable. Furthermore, 170 million people live in "gray areas" where they are exposed to noise causing serious annoyance. The predominant contribution to this high burden by environmental noise arises from transportation on road, on rail and in the air. The costs caused by noise pollution are estimated to be 0.2 to 2 percent of the gross domestic product. Using the lower value, this estimate means annual financial losses due to environmental noise of more than 12 billion Euros.

The first regulative activity of the EU against noise was focused on the limitation of noise emission from motorized road vehicles due to a directive issued in 1970. Amendments with lower noise limits and further directives for other noise sources followed. However, the actual noise situation has hardly improved. For example, the noise emission from road transport has not significantly changed. There are several reasons for the low efficiency of this legislative limitation, such as: no significant effect on tyre/road noise emission, insufficient strictness of the limits during the first years, "inertia effect" due to slow change of old for new vehicles, differences between real traffic and type approval test concerning road surfaces and vehicle driving conditions, increasing power of engines and increasing traffic volume (number of vehicles and kilometers of road).

Thus, due to the increasing severity of the noise situation in Europe and the expected future increase of the traffic volumes, the European Commission has started a new policy towards a quieter environment considering not only the noise emission, but also noise emission situation. It is based on a coherent set of regulations to limit the emission of noise from various sources and to assess and reduce the total exposure to environmental noise. In this context, a new directive about the assessment and management of environmental noise has been adopted in June 2002 that will be briefly described below. But despite these activities, further intensive research is still required to improve the situation and to support the further development of the EU noise policy and the related directives.

So far, legislation on environmental noise has been divided into two major categories, namely, EU legislation on noise emission by products (cars, trucks, aircraft and industrial equipments), essentially market access laws for type testing of conformity, and Member

State legislation on allowable noise levels in the domestic environment. In principle, these approaches are complementary and the combination should produce a good result. In order to improve the situation, the Commission has suggested a new framework for future action starting with: *"a proposal for a directive providing for the harmonization of methods of assessment of noise exposure and the mutual exchange of information. The proposal could include recommendations for noise mapping and provision of information on noise exposure to the public. In a second stage consideration could be given to the establishment of target values and the obligation to take action to reach the targets".*

In 1999 the Council adopted a Strategy on the integration of Environment in the Transport Policy in which the problem of noise from road, rail and air transport is identified as one of the most urgent areas for action. The Communication on Air Transport and Environment contains recommendations for the harmonization of noise indicators and assessment methods for aircraft noise and to the forthcoming framework directive on environmental noise. The Transport and Environment Reporting Mechanism, part of the EU program and action in relation to environment and sustainable development, has identified the indicator "exposure of population to traffic noise" in the group "environmental consequences of transport" and shown that no harmonized methodologies or data are available. A solution is expected from the EU Noise Policy, the related working groups and the future framework directive on environmental noise.

Important elements of this proposed directive are similar to the contents of the Directive on ambient air quality assessment and management: viz. data collection in agglomerations; action plans; adequate information for the public; improvement of computation and measuring methods; collection of data and reporting by the Commission. The proposal therefore supplements to the well-known air quality directive, covering another important environmental aspect particularly for the urban environment. Additionally, the proposal covers several other aspects such as noise control in the rural environment and the protection of relatively quiet areas.

The OECD identified the following factors to be of increasing importance in the future:

- The expanding use of increasingly powerful sources of noise.
- The wider geographical dispersion of noise sources, together with greater individual mobility and spread of leisure activities.
- The increasing invasion of noise, particularly into the early morning, evenings and weekends.
- The increasing public expectations that are closely linked to increases in incomes and in education levels.

The OECD offered four groups of measures as a solution to forthcoming problems:

- Strengthening of present noise abatement policies and their applications.
- Further sharpening of emission standards.
- Co-ordination of noise abatement measures and transport planning, to specifically reduce mobility.
- Co-ordination of noise abatement measures with urban planning.

The concept of the environmental noise impact analysis is central to the philosophy of managing environmental noise. The environmental noise impact analysis should be required before implementing any project that would significantly increase the level of environmental noise in a community (typically, greater than a 5dB increase). The first step

in performing the environmental noise impact analysis is to develop a baseline description of the existing noise environment. Next, the expected level of noise from a new source is added to the baseline exposure level to produce new overall noise level. If the new total noise level is expected to cause an unacceptable impact on human health, trade-off analyses should then be performed to assess the cost, technical feasibility and community acceptance of noise mitigation measures. It is strongly recommended that standardized procedures for performing environmental noise impact analysis comprise:

- Assessment of adverse health effects;
- Estimation of the population risk;
- Calculation of exposure-response relationships;
- Assessment of risks and their acceptability.

Carrying out a cost-benefit analysis is very important and includes:

- Identification and cost analysis of control action (such as emission abatement strategies and tactics).
- Assessment of noise and population exposure, with and without the control action.
- Identification of benefit categories, such as improved health and reduced property loss.
- Comparison of health effects, with and without control action.
- Comparison of estimated costs of control action with benefits that accrue from such action.
- Sensitivity and uncertainty analysis.

The setting of standards should involve stakeholders at all levels (industry, local authorities, nongovernmental organizations and the general public), and should strive for social equity or fairness to all parties involved. It should also provide sufficient information to guarantee that the scientific and economic consequences of the proposed standards are clearly understood by the stakeholders. Transparency in moving from noise guidelines to noise standards helps to increase public acceptance of necessary measures. Raising public awareness of noise-induced health effects (changing of risk perception) also leads to a better understanding of the issues involved (risk communication) and serves to obtain public support for necessary control action, such as reducing vehicle emissions. Noise standards should be regularly reviewed, and revised as new scientific evidence emerges.

Although much research has been done to evaluate the human population exposure to noise level, many explorers warn that it is very difficult to quantify noise effects, because of:

- different noise level tolerance of the population;
- different types of environmental noise sources;
- different methods for obtaining noise exposure information, and
- different noise indicators.

Therefore, in the last years, the basic concept for noise indicator selection has been established:

- $L_{\mathrm{Aeq,T}}$ is the basic noise indicator;
- Two indicators are needed: one for describing annoyance and the other for describing sleep interference;
- Accounted physical character of noise (pure tone noise, impulse noise, low-frequency noise) and character of source (road, rail, aircraft) are needed, as well;

The basic objectives of noise indicator harmonization are:

- direct comparison of noise situations in different states;
- facilitating the exchange of information about noise levels;
- monitoring of noise situation and noise mapping in uniform manner;
- comparison of alternative noise control measures;
- rationalization of computation and measurement technique leading to simpler and possibly lower cost instrumentation systems and calculation packages.

The European Commission established the working groups in 1998 with the specific mission in noise regulation harmonization. The mission of the first working group was to recommend physical indicators to describe noise from all outdoor sources for assessment, mapping, planning and control purpose and to propose methods of implementation.

The goal of noise management is to maintain low noise exposures so that human health and well-being should be protected. The specific objectives of noise management are to develop criteria for the maximum safe noise exposure levels, and to promote noise assessment and control as part of environmental health programmes. The United Nations´ Agenda 21 (UNCED 1992), as well as the European Charter on Transport, Environment and Health (London Charter 1999), both support a number of environmental management principles on which government policies, including noise management policies, can be based.

These include:

1. **The precautionary principle**. In all cases, noise should be reduced to the lowest level achievable in a particular situation. Where there is a reasonable possibility that public health will be damaged, action should be taken to protect public health without awaiting full scientific proof.
2. **The polluter-pays principle**. The full costs associated with noise pollution (including monitoring, management, lowering levels and supervision) should be met by those responsible for the source of noise.
3. **The prevention principle**. Action should be taken where possible to reduce noise at the source. Land-use planning should be guided by an environmental health impact assessment that considers noise as well as other pollutants.

The government policy framework is the basis of noise management. Without an adequate policy framework and an adequate legislation it is difficult to maintain an active or successful noise management programme. A policy framework refers to transport, energy, planning, development and environmental policies. The goals are more readily achieved if the interconnected government policies are compatible, and if issues that cross-different areas of government policy are coordinated.

A legal framework is needed to provide a context for noise management. While there are many possible models, an example of one is given in Figure 1. This model depicts the six stages in the process for developing and implementing policies for community noise management. For each policy stage, there are groups of 'policy players' who ideally would participate in the process.

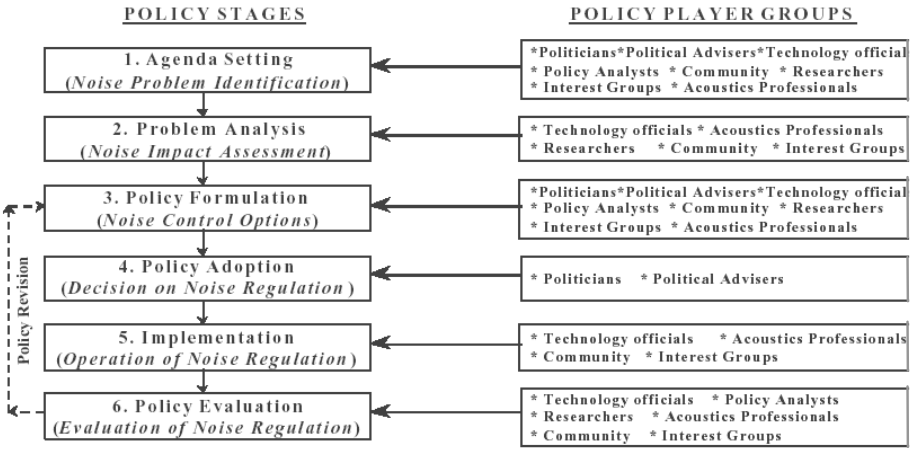

Fig. 1. A model of the policy process for community noise management

STATE-OF-THE ART NOISE INDICATORS

There have been several reviews of the noise regulations in different countries [6,7,8]. From these surveys it is clear, however, that it is difficult to keep up since the regulations tend to evolve.

In a majority of Member States basically the same noise descriptor is used: rating noise level L_r (according to ISO 1996) for industry and A-weighted equivalent noise level L_{Aeq} for road and rail noise. The exceptions are Belgium where L_{95} is used for industry noise, the UK where L_{10} is used for road noise and Denmark where L_{Amax} is used for rail noise.

CRITERIA FOR SELECTING NOISE INDICATORS

When discussing the harmonization of noise indicators, a set of criteria is required to enable the selection from likely candidates. The criteria for noise indicators depend not only on scientific validity but also on how that indicator will be used in practice and applied in the legislation.

The following set of criteria can be formulated:

- **Validity** – relationship with effects, above all speech interference, annoyance and sleep disturbance;
- **Practical applicability** – ease of calculation from available data, or measurement using available equipment;
- **Transparency** – small number of indicators - preferably one than can be easily explained to population;
- **Enforceability** – use of indicator in assessing changes or when set limits are exceeded.
- **Consistency** with the widespread use of indicators in current practice of most countries.

During the selection of noise indicators the costs associated with each indicator should be taken into account: costs related to the introduction phase, which are the one-time conversation costs and cost related to the practical use of indicator.

ALTERNATIVE NOISE INDICATORS

One of the models for selecting noise indicators is based on discrete hierarchical steps [9]. The basic concept is that a sound environment can be thought of as being composed of a large number of short sound samples each made up of contribution from different frequency bands.

The purpose of an indicator is to reduce this large volume of information to a quantity which is still meaningful but easier to handle. The process of reduction of large volume information include the following steps:

1. Reduction of frequency content to one number. The A-weighted procedure is most often used. Other possibilities are B, C, D, PNL or Zwicker-Stevnes method.
2. Description of sound event by one number. At present only two procedures are used: either the energetic summation with no weightings, which gives L_{AE} or the maximal level per event $L_{Amax.}$
3. The sum of the number of events per day period (day, evening, night). Again there are two commonly known procedures:
   - energetic summation with a weighting factor 10, which gives L_{Aeq} per event
   - summation with a weighting factor 13.
4. Description of 24h sound event by one number. In its simplest form without adjustments, the day, evening and night periods are summed and averaged to give a 24 hour value. In the more elaborate forms either evening/night or night only corrections are included. Factors of 10 for the night, or a combination of factors 3.16 (5dB) for 4 hour evening and 10 for 8 hours night are currently in use.

A long-term calculation of value by means of summation and averaging. Although this is rarely done, this step could further be broken down into weekday/weekend periods and summer/winter day periods with or without their accompanying weightings.

THE VISION OF 2020 – BASIC TARGETS

In the past, the regulation of noise emission did not lead to significant reduction in noise emission in domestic areas so the European noise policy was revised to focus also on noise reception. Thus, the Green Paper of 1996 defines that "*no person should be exposed to noise levels which endanger health and quality of life*" as the aim of future noise policy. Although first targets in relation to this objective were only set up to the year 2000, the aim continues to be valid and has been adopted as the long-term vision. This vision for the development of the noise policy up until 2020 suggests "*to avoid harmful effects of noise exposure from all sources and to preserve quiet areas*". Hence, the long-term goal is not only to reduce the noise exposure where it is too high, but also to keep the low noise levels of the already quiet areas.

An approach for translating this long-term visionary goal into goals for noise control at source is given in the paragraph below.

For road traffic, the visionary targets for noise reduction at source are up to 10dB(A). The most important areas where new or improved solutions and system approaches are needed are:

- Tyre/road noise (low noise tyres and quiet maintainable surfaces) because tyre/road noise is the predominant noise element in many traffic situation, especially at mid and higher vehicle speeds;
- Propulsion noise consisting of engine, transmission and exhaust noise which is a significant element during acceleration of heavy trucks, especially in urban traffic;
- Traffic management to make possible road traffic with reduced noise emission, particularly in regard to preventing congestion and improving safety;
- Improved regulations related to noise emission.

For rail traffic, the visionary targets for noise reduction at source are up to 20dB(A) for freight trains and 5dB(A) for high-speed trains. The most important areas where new or improved solutions and system approaches are needed are:

- Rolling noise (mainly for freight trains, arising from wheel and rail roughness caused by cast iron block brakes) requiring better control of the growth of wheel and rail roughness;
- Aerodynamic noise from high-speed trains;
- Curve squeal and brake screech noise requiring a better understanding of the generation and the interaction of the different parameters.

For air traffic, the target for the vision of 2020 is a 10dB noise reduction per aircraft operation. The most important areas where new or improved solutions and system approaches are needed are:

- Noise reduction at the aircraft through novel aircraft and engine architecture and new generation noise technologies;
- Optimized aircraft operation.

The target for the vision of 2020 is to halve the noise annoyance caused by outdoor equipment. A strong basis for the reduction of noise from outdoor equipment is given by the Directive 2000/14/EC relating to the noise emission in the environment by outdoor equipment which needs, however, further development toward higher efficiency in real world reduction. For the achievement of the above target, research is required for the following prime topics:

- Identification of the most suitable noise-relevant parameters per outdoor equipment class or type;
- Correlation between noise emission, performance parameters and real operation nuisance;
- Effect of single and combined noise sources on noise perception.

BASIC ELEMENTS OF ENVIRONMENTAL NOISE DIRECTIVE

The noise legislation at European level is based on the new directive related to environmental noise and a number of directives governing the noise emission from a variety of sources like motor vehicles and their tyres, motorcycles, aircrafts, outdoor machinery etc. The new environmental noise directive [5] aims at protecting the health and well-being of the population from harmful effects of environmental pollution. Its transposition is based on the shared responsibility of the EU and the member states, as some aspects are covered best at EU level, and others at national and local level.

The key elements of the environmental noise directive are:

- assessment of environmental noise by:
  - common noise indicators
  - common assessment methods
  - strategic noise mapping of major agglomerations, roads, railways and airports (phase 1 until 2007, phase 2 until 2012, then every 5 years)
- action plans (on national / local basis; phase 1 until 2008, phase 2 until 2013, then every 5 years)
  - reducing noise where necessary
  - maintaining environmental noise quality where it is good
- information for the public (" ... to increase public awareness concerning noise")
  - information on noise maps and action plans
  - EC summary report every five years

The basis for the assessment of environmental noise is strategic noise maps, which are to be established by common noise indicators and methods. Strategic noise maps for agglomerations shall put a special emphasis on the noise emitted by road and rail traffic, airports and industrial activity sites including ports. Strategic noise maps present data on one of the following aspects:

- existing previous or predicted noise situation in terms of a noise indicator,
- exceeding of a limit value,
- estimated number of dwellings, schools and hospitals in a certain area that are exposed to specific noise indicator,
- estimated number of people located in an area exposed to noise.

On the basis of the assessment provided by the strategic maps, competent authorities must draw up an action plan to reduce noise where it is necessary and to maintain environmental noise quality where it is good. The directive does not set any limit value, nor does it prescribe the measures to be used in the action planes, which remain at the discretion of the competent authorities. The action plans can include, among others, the following measures: traffic planning, land-use planning, technical measures at noise sources, selection of quieter sources and reduction of sound propagation use of noise barriers, tunnels, insulation of dwellings etc.

The third key element of directive is information of the public about strategic noise maps and action plans. This information shall be clear, comprehensible and accessible. A summary setting out the most important points shall be provided.

The directive obligates the member States to designate at the appropriate levels the competent authorities and bodies responsible for implementation of the directive, including authorities responsible for making and approving noise maps and action plans for agglomerations, major roads, major railways and major airports.

Noise assessment methods

Two main indicators are used for noise assessment: L_{den} and L_{night}. The day-evening-night level L_{den} is defined by the following equation:

$$L_{den} = 10 \log \frac{1}{24} (12 * 10^{0.1 * L_{day}} + 4 * 10^{0.1 * (L_{evening} + 5)} + 4 * 10^{0.1 * (L_{night} + 10)}) \text{ [dB(A)]} \quad (1)$$

in which:

L_{day} [dB (A)] – is the A-weighted long-term average sound level determined over the day periods of a year,

$L_{evening}$ [dB (A)] – is the A-weighted long-term average sound level determined over the evening periods of a year,

L_{night} [dB (A)] – is the A-weighted long-term average sound level determined over the night periods of a year, in which:

- the day is 12 hours, the evening 4 hours and the night 8 hours,
- the default values of the start and end of the day (night, evening) are 07:00-19:00 (19:00-22:00, 22:00-07:00); the Member States choose the different values but same for all sources.

In some cases, in addition to L_{day} and L_{night} and where appropriate L_{day} and $L_{evening}$ it may be advantageous to use special noise indicators and related limit values.

The height of the assessment point depends on the applications:

- in the case of computation for the purpose of strategic noise mapping in relation to noise exposure in and near buildings, the assessment points must be 4.00±0.2m above the ground;
- in the case of measurement for the purpose of strategic noise mapping in relation to noise exposure in and near buildings, other heights may be chosen, but they must never be less than 1.5m above ground and results should be corrected in accordance with an equivalent height of 4m;
- in the case such as acoustical planning and noise zoning other heights may be chosen, but they must never be less than 1.5m above ground

The different calculation methods are used for assessment of noise indicators by computation related to noise sources. The directive recommends the following methods:

- XPS 31-333 – The French national computation method for road traffic noise;
- RMR – The Netherlands national computation method for rail traffic noise;
- ECAC.CEAC – Computation method for take-off and landing of airplanes;
- ISO 9613-2 – The international standard for computation of industrial noise.

Deadline for directive implementation

The directive fixes the deadline for implementation of directive and taking proposed measures:

- 30.6.2005. – The Member States shall inform the Commission of the major roads which have more than six million vehicle passages a year, major railways which have more than 60000 train passages per year, major airports and the agglomerations with more than 250000 inhabitants within their territories. The data can be updated every five years.
- 30.6.2007. – The Member States shall ensure strategic noise maps showing the situation in the preceding calendar year for all agglomerations with more than 250000 inhabitants and for all major roads which have more than six million vehicle passages a year, major railways which have more than 60000 train passages per year, major airports within their territories.
- 18.7.2008. – The Member States shall ensure the action plans for places near the major roads which have more than six million vehicle passages a year, major railways which have more than 60000 train passages per year, major airports and for agglomerations with more than 250000 inhabitants.

- 31.12.2008. – The Member States shall inform the Commission of all the major roads, major railways and all the agglomerations within their territories.
- 30.6.2012. – The Member States shall ensure strategic noise maps showing the situation in the preceding calendar year for all agglomerations and for all major roads, major railways, and major airports within their territories. The data can be updated every five years.

BASIC ELEMENTS FOR NATIONAL LEGISLATIVE

The procedures and methods for environmental noise measurement and evaluation are included in the following standards and regulations:

- JUS U.J6.090 (Community noise measurement),
- JUS ISO 1996 (Description and measurement of environmental noise),
- JUS U.J6.205 (Acoustical zoning),
- Regulations for permissible noise level in the environment,
- Environment noise measurement method.

Actual environmental regulations of Serbia that deal with environmental noise regulate that:

- Municipalities take noise reduction measures and determine the settlement area, rest area and recreational area and enable permanent noise monitoring.
- The technical documentation for the major roads, the major rail and airports and other noise sources constitutes the technical solution for noise and vibration reduction.
- The noise sources can be put into circulation if they have a chart with the data regarding noise level generated during regulated condition of using and maintenance.
- The noise source built into the buildings and equipment and devices used in industries can have the instruction about noise reduction measures in addition to the chart with the data regarding generated noise level.
- The noise source can be used and maintained in such a way that the generated noise does not exceed the noise limit in environment.

For description and evaluation of environmental noise, the rating noise level is used as an equivalent A – noise level that refers to defined referent time, with correction for noise character.

The base of this procedure is measurement of A – equivalent noise level by application of three recommended methods: integration procedure, sampling method and sorting method. Measurement of A – equivalent noise level is an application for all types of noise sources, except for source of intermittent noise character. Equivalent noise level is determined by measuring incidental noise level at height of 1,2 to 2.0 meter above the ground. For exceptional measurement tasks (wall screen, ground slope, large ground dumping) the measurement can be done on the height of 4 meters.

After determination of A – equivalent noise level, it should be determined if the noise of observed sources contains impulses, emphasized tones or some different acoustical data, in order to create a measured level correction.

For rating noise level determination, besides observed noise character, the rate of duration of evaluated noise and reference interval that has been used for noise evaluation is very important. Since Yugoslav regulations do not explicitly define duration of reference interval, starting from the practices applied in most of the countries, authors of this paper

have accepted division of a day into two referent periods. That division has been defined by Yugoslav regulations, so for measurements in day conditions the referent interval is 16 hours (6:00-22:00), and for night measurements 8 hours (22:00-06:00).

PROPOSALS FOR THE BASIC ELEMENTS OF IMPLEMENTATION

The END implementation at national and local level means amending existing acts or defining a new environmental protection act with the three key elements of the Directive included.

The END implementation means clear definition of the goals, deadlines and institutional responsibility in the areas of:

- Strategic noise mapping at national and local level.
- Action plans development at national and local level.
- Information and public participation.

Strategic noise mapping at national level must include all sources of noise pollution that originate from various types of traffic and all inhabited places where population count reaches above the defined limit. Moreover, noise mapping at local level must include all living areas where negative noise effects may be expected regardless to location of the traffic routes and the population count.

In the process of data assessment necessary for the Directive implementation, all institutions, whether state or private, are obligated to submit required data without compensation. This mostly relates to the data that defines emission of individual noise sources, such as: the number, type, and speed of motor vehicles and trains, flight corridors, and industrial facilities data. Institutions are also obligated to submit data on the terrain configuration and population count living in the area.

The environmental protection act also needs to oversee the compilation of according regulations that closely define realization of the three key elements of the Directive in the areas of:

- Defining criteria for allocation of the inhabited places that need strategic mapping.
- Defining criteria for classifying quiet zones in inhabited areas.
- Defining of other major noise pollution sources that are included in strategic mapping.
- Defining criteria for action plan development.
- Adopting methods for modeling and prediction of main sources of noise level, where main sources are road traffic, railway traffic, airports, and industrial facilities. If there are no national methods existing, methods given by the END should be applied. In case where national methods do exist, they can be harmonized with methods defined by the Directive in order to give equivalent results.
- Adopting methods for evaluation of population count affected by defined harmful noise levels.
- Adopting noise indicators L_{den} and L_{night} : Level L_{den} can be defined as an equation [2]. Period of the day needs to be separated into three time periods: day, evening and night. Time intervals depend on the geographic position, climate conditions, and adopted habits of specific area.

$$L_{den} = 10\log\frac{1}{24}(t_d * 10^{0.1*L_{day}} + t_e * 10^{0.1*(L_{evening}+5)} + t_n * 10^{0.1*(L_{night}+10)}) \text{ [dB(A)]} \quad (2)$$

where:

t_d [h] – is daytime period

t_e [h] – is evening time period

t_n [h] – is nighttime period

with condition: $t_d + t_e + t_n = 24$

Successful implementation of the END also means clear definition of institutional responsibility at all levels.

Amending the environmental protection act or enacting the new act, with the three key elements of the Directive inclusive, is the responsibility of appropriate ministries (environmental protection, spatial planning, etc), and the municipal government.

For carrying out the strategic noise mapping, responsibility is defined for:

- Companies conducting transport of goods and passengers by railway – for major railway routes.
- Institutions authorized for building of land traffic routes – for major road routes.
- Institutions authorized for maintaining airport functions – for airports.
- Municipal and city government – for inhabited places.

CONCLUSION

Successful noise management should be based on the fundamental principles of precaution: the polluter pays principle and prevention. The noise abatement strategy typically starts with the development of noise standards or guidelines, and the identification, mapping and monitoring of noise sources and exposed communities.

Implementation of the Environmental Noise Directive at the national and local level and harmonization of the national laws with the European laws in the area of environmental noise management and evaluation, have both created conditions for the realization of two key targets in European vision of fighting against noise until 2020:

- No person should be exposed to noise levels that endanger health and quality of life.
- To avoid harmful effects of noise exposure from all sources and to preserve quiet areas.

Noise indicators harmonization is a very important component of the whole noise reduction strategy. The suggested noise indicators should be mainly used for evaluation of annoyance and interfering with sleep and speech in the residential area. It is recommended that the suggestion about noise indicator harmonization should be adopted as soon as possible if it does not violate the whole noise control system in national regulations.

Noise modeling is a powerful tool for noise control strategy application. These models should be verified by measurement data. The noise parameters describing the major sources must be known.

Noise management should:

- Start monitoring human exposures to noise.
- Have health control require mitigation of noise emissions. The mitigation procedures should take into consideration specific environments such as schools, playgrounds, homes and hospitals; environments with multiple noise sources, or which may amplify the effects of noise; sensitive time periods, such as evenings, nights and holidays; and groups at high risk, such as children and the hearing impaired.

- Consider noise consequences when making decisions on transport-system and land use planning.
- Introduce surveillance systems for noise-related adverse health effects.
- Assess the effectiveness of noise policies in reducing noise exposure and related adverse health effects, and in improving supportive "soundscapes."
- Adopt these Guidelines for Community Noise as long-term targets for improving human health.
- Adopt precautionary actions for sustainable development of acoustical environments.

Harmonization of measurement methods and noise monitoring systems together with the data exchange are important steps that should be taken in the future aimed at noise level reduction and human exposure to exceeding levels.

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STRATEŠKI PRAVCI U IMPLEMENTACIJI DIREKTIVE O BUCI U ŽIVOTNOJ SREDINI NA MEĐUNARODNOM I NACIONALNOM NIVOU

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Osnovna karakteristika strategije borbe protiv buke u Evropi do 1996. godine bila je definisanje propisa koji ograničavaju emisiju buke potencijalnih izvora, pre svega drumskog saobraćaja, aviona i opreme koja se koristi na otvorenom prostoru. Iako su granični nivoi bili sve strožiji, iz godine u godinu, nije napravljen značajan pomak u redukciji imisije buke. Zbog toga se strategija menja i fokusira na mesto prijema buke. Dokumentom "Green paper" iz 1996. godine definiše se osnovni cilj buduće strategije borbe protiv buke da "ni jedna osoba ne treba da bude izložena nivou buke koji može ugroziti zdravlje i kvalitet života". Struktura nove strategije buke definisana je direktivom 2002/43/EC koja se odnosi na ocenu i menadžment bukom u životnoj sredini (END). Tri ključna elementa direktive obuhvataju ocenu buke u životnoj sredini strategijskim mapiranjem buke, implemntaciju akcionih planova za redukciju buke tamo gde je to neophodno i informisanje javnosti o nivoima buke i njenim efektima. Direktivom su definisani zajednički indikatori buke i metode za strategijsko mapiranje buke kao i rokovi za implementaciju direktive. Implementacija direktive na nacionalnom i lokalnom planu podrazumeva donošenje novih ili izmenu postojećih zakona. U radu je dat prikaz koraka koje je neophodno preduzeti za usaglašavanje nacionalnog zakonodavstva sa osnovnim principima i elementima END direktive.