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Project "The assessment and management of environmental noise"

Final Report

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Consortium

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Abbreviations

CFCU	Central Finance and Contracting Unit
EAS	Environmental Accession Strategy
EC	European Commission
ECD	Delegation of the European Commission
END	EU- Directive on Environmental Noise
EU	European Union
IA	Implementing Agency
ISPA	Instrument for Structural Polices for Pre-accession
MAs	Management Authorities
MCRD	Ministry of Construction & Regional Development of the Slovak Republic
MTPT	Ministry of Transport, Posts and Telecommunications
MEuro	Millions of Euro
MoE SR	Ministry of Environment of the Slovak Republic
MoH	Ministry of Health of the Slovak Republic
NPAA	National Programme for the Adoption of the Acquis Communitaire
NPHA	National Public Health Authority of Slovak Republic
NRC	Department of National Reference Centre for Noise and Vibration of Public Health Authority Bratislava
PAO	Programme Authorising Officer
SR	Slovak Republic
TA	Technical Assistance
ToR	Terms of Reference
WHO	World Health Organisation

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1 Project introduction

1.1 Project Background

The Slovak Republic carried out the National Programme for the Adoption of the *Acquis Communautaire* (NPAA) as one of the key documents in the process of approaching the acquisition of full membership in the European Union.

In the pre-accession process and the process of gradual harmonisation of Slovak legislation with European, the environmental directives take very important place.

A special and very significant theme of environmental area is the protection of environment and health against noise. Noise belongs to the one of the most important psychosocial factors of environment quality and quality of life in general. It may cause hearing loss that impairs life quality by causing sleep disturbance, high annoyance, and other negative health effects.

It is part of community policy to achieve a high level of health and environmental protection and one of the objectives to be pursued is protection against noise. In the Green Paper on Future Noise Policy [1], the Commission addressed noise in the environment as one of the main environmental problems in Europe. Preventive measures in this field of public health will have to be taken according to EU requirements and WHO research reports in the nearly future.

Certain categories of noise emissions from products are already covered by community legislation, such as Council Directive 70/157/EEC [2] relating to the permissible sound level and the exhaust system of motor vehicles, Council Directive 77/311/ EEC [3] of 29 March 1977 relating to the driver perceived noise level of wheeled agricultural or forestry tractors, Council Directive 80/51/EEC [4] on the limitation of noise emissions from subsonic aircraft and its complementary directives, Council Directive 92/61/EEC [5] relating to the type-approval of two or three-wheel motor vehicles and Directive 2000/14/EC [6] of the European Parliament and of the Council relating to the noise emission in the environment by equipment for use outdoors.

In the last year the Commission has adopted Directive 2002/49/EC [7] of the European Parliament and the Council of 25 June 2002 relating to the assessment and management of environmental noise.
The aim of this Directive is to define a common approach intended to avoid, prevent or reduce the harmful effects, including annoyance, caused by exposure of environmental noise. The following actions shall be implemented progressively:

(a) determination of exposure of environmental noise, through noise mapping, by methods of assessment common in the Member States,
(b) ensuring that information on environmental noise and its effects is made available to the public,
(c) adoption of action plans by the Member States, based upon noise-mapping results, with a view to prevent and reduce environmental noise where necessary and particularly where exposure levels can induce harmful effects on human health and to preserve environmental noise quality where it is good.

The noise theme is of a wide scope and there are many different institutions, central offices of state administration responsible for a noise control in the Slovak Republic (SR), specially Ministry of Health, Ministry of Environment, Ministry of Transport, Post and Telecommunications, State Office for Standardization, Measurement and Testing and their subordinate organisations. The Ministry of Health of SR (MoH) was appointed during the pre-accession process by the SR Government Decision No.1232 from 13^{th} November 2002 as a responsible institution for harmonisation of the Slovak law with the Directive 2002/49/EC. MoH provides this through its subordinate organisation National Public Health Authority and Department of National Reference Centre for Noise and Vibration of Public Health Authority Bratislava, Capital of Slovakia (NRC for noise and vibration), as a top specialised centre in the area of environment and health noise protection.

NRC for noise and vibration is presently preparing the proposal of the Legal Act about assessment and management of environmental noise, harmonised with EU requirements, which should be submitted to the Slovak Parliament before June 2004. Successful implementation of entire Directive 2002/49/EC including its all amendments requires lot of high sophisticated work of a large scope. Considering that, there are not enough expert capacities available in responsible institutions in Slovak Republic and there is an inevitable need for foreign expert participation in order to make use of their capacity and experiences from the harmonisation process and praxis.

1.2 Project Description

1.2.1 Overall objective

The harmonization and implementation of the Directive 2002/49/EC with the Slovak legislation in the area of Environment and Health Noise protection.

1.2.2 Specific objectives of the project

Preparedness of all necessary technical and human resources for direct implementation of all regulations related to the Directive 2002/49/EC in the Slovak Republic.

1.2.3 Requested services

One framework arrangement is envisaged, which will cover following activities:

Activity 1
Technical and legislative support of the Directive 2002/49/EC implementation into Slovak legislation.

This activity includes, but is not limited by:

1) in close cooperation with Slovak experts (relevant employees of NPHA) preparation of proposal on appropriate institutional framework to ensure entire implementation of Directive 2002/49/EC (e. g. determination of relationships among all concerned institutions, duty to provide relevant information, duty to carry out necessary activities etc.),

2) in close cooperation with Slovak experts to propose the model of action plan (according to the conditions of the Directive 2002/49/EC) for application of noise control and noise assessment,
3) 4-days training of 10 responsible NPI employees. The training will contain detailed explanation of particular paragraphs and provisions of Directive 2002/49/EC and its Annexes, related documents and technical standards,
4) expert's opinion on current proposal of Act of the National Council of the SR on environmental noise and related legislation, which should be fully harmonized with the Directive 2002/49/EC.

Activity 2

Development of detailed methodologies for measurement and calculation of environmental noise (emitted by the major sources, in particular road and rail vehicles and infrastructure, aircraft, outdoor and industrial equipment and mobile machinery) and methodology for development of noise mapping and action plans, especially:

1) re-definition of the noise indicators and theirs measurement and assessment methodology according to the EU requirements,
2) state of the art analysis of calculation methodology and procedures, selection and modification of appropriate methodology for Slovak conditions,
3) development of the methodology for noise mapping,
4) realization of terrain environmental noise measurement to verify proposed methodology,
5) training of relevant NPI employees (ca. 15 people) to work and use above- mentioned methodology.

Training duration - 2 days

These 9 partial activities have been detailed and modified (supplemented) in agreement with all parties included. The result was a work plan with the steps necessary to achieve the defined results.

2 The general approach of the expert work in this project

This paragraph describes shortly the project development covering the period from April to November 2004. During this period several missions of experts to Slovakia were carried out. These experts are

- Dr. Wolfgang Probst (Team leader)
- Dr. Béla Búna (Hungary, Budapest)
- RNDr. Peter Pavlík (Slovakia, Martin)
- Ing. Milan Kamenicky (Slovakia, Bratislava)

Two main topics took most of the effort of the experts work.
The first one is to develop proposals about the institutional framework to ensure entire implementation of Directive 2002/49/EC.
The second and more technical one is the proposal and implementation of the methodology used to calculate the noise levels and to get all the information needed according to Annex VI of the directive.

Four legally relevant documents should ensure and support the implementation of the directive 2002/49/EC.

1) The "LAW OF THE GOVERNMENT ABOUT ASSESSMENT AND CONTROL OF ENVIRONMENTAL NOISE" [8].
   This Law mirrors nearly 1:1 the Directive 2002/49/EC. It should not contain details, that may be changed or modified from time to time.
2) The "DECREE OF THE GOVERNMENT ABOUT STRATEGIC NOISE MAPS AND ACTION PLANS FOR NOISE PROTECTION" [9]
   This decree defines details of strategic noise maps and action plans. It is also the image of a part of the Directive 2002/49/EC.
3) The "DECREE OF THE MINISTRY OF HEALTH ABOUT PROVISION OF DATA FOR STRATEGIC NOISE MAPS" [10]
   This decree should define the responsibility of persons or institutions to acquire the necessary information, to support those responsible for noise mapping with the necessary data and lay down the consequences if these duties are not fulfilled.
4) The "GUIDE OF THE NATIONAL PUBLIC HEALTH INSTITUTE ABOUT THE METHODS TO CALCULATE THE NOISE INDICATORS FOR STRATEGIC NOISE MAPS" [11]
   With this guide all technical and organisational details not defined in the Law and in the Decrees of Government and Ministry of Health are regulated.

Figure 1 shows the main documents that were planned to be developed in the frame of this project.

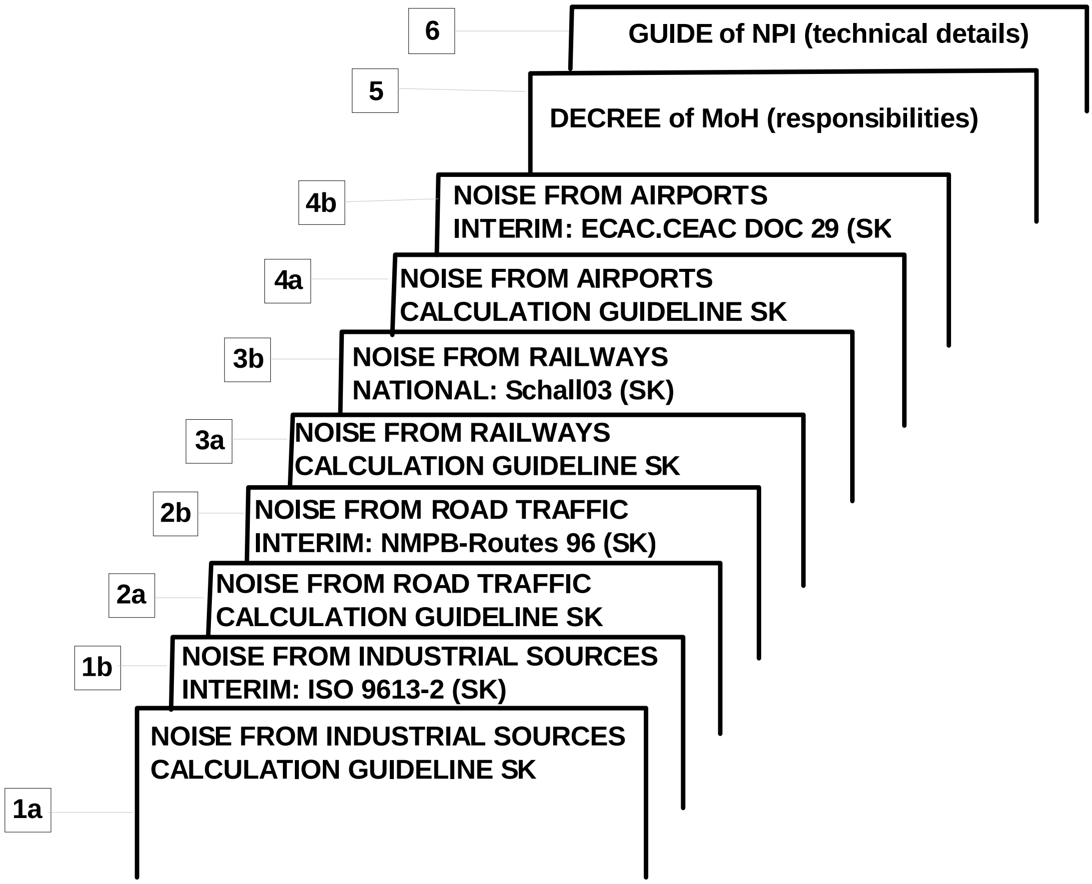

Figure 1 Main documents that should be developed

3 Law of the government about assessment and control of environmental noise

As mentioned above, this law was in the process of approval before the start of this project. It is a direct implementation of parts of the directive and no activities in the frame of this project had to be carried out.

4 Decree of the government about strategic noise maps and action plans for noise protection

This decree is also a direct implementation of parts of the directive. No activities about it in the frame of this project.

5 Decree of the ministry of health about provision of data for strategic noise maps

The following are recommendations of the expert group worked out to support the development of the Decree. It is well known that the information is too detailed to be integrated completely. Nevertheless it can be used to create additional specifications and guidelines.

5.1 Purpose

To implement the Directive 2002/49/EC, the government's law about the assessment and control of the environmental noise has been passed. Article 1, Paragraph 5 of this law specifies duties for physical persons, companies and legal persons regarding the provision of information or the data that are necessary.
The data to be made available are described in the following.

5.2 Roads

5.2.1 Types

The Law [8] distinguishes major roads and other roads.

5.2.2 General

Within the framework of the law, road data are all data that refer to the road as a noise source and that are required and adequate to calculate noise indicators according to Annex 1, Section (1) of the Decree of the Government [9].

5.2.3 Geometry data

From the point of view of data, a road consists of individual sections assigned a unique common identifier.
Sections have uniform sound-related properties (attributes) over their entire length. If one or more of these properties change at a road cross-section, there is a change in section.
Road sections with essentially similar widths and similar traffic flows in both directions (as an average over time) are shown by their center axis and two parallel lines to show the width. Independent of the number of lanes, this width is the distance of the outermost lane axes. The sections are assigned all of the property data stated below by means of unique identifiers.
In the case of complicated road geometries with strongly fluctuating cross-section or with significantly asymmetric traffic volume, each driving lane is described as if it were a separate road with a complete attribute data record and the width 0.
The geometry data can be provided separately from the attribute data in one of the permitted geometry data formats if each data record has a unique identifier that is also used to identify the corresponding attribute data.

5.2.4 Attribute data

Each section is uniquely assigned all of the property data (attribute values) necessary for the sound-related description. Essentially, this is sound-related relevant information on

- the road construction such as
  - road surface (no. of the road surface from a given list)
  - longitudinal gradient for sections with a specified minimum upward incline
- the roadside buildings such as mean distance and height of the closed façades bordering the road space
- the traffic flows such as
  - the number of motor vehicles and proportion of trucks or heavy vehicles, each specified separately for the three time blocks daytime, evening and nighttime
  - the permitted maximum speeds in the three time blocks, if applicable separately for passenger cars and trucks

The property data can be provided separately from the geometry data in one of the permitted database formats if each data record has a unique identifier that is also used to identify the corresponding geometry data.
The attribute data can be provided together with the geometry data in a permitted object description format.

5.3 Railways

5.3.1 Types

The law distinguishes major railways and other railways.

5.3.2 General

Within the framework of this law, railway data is all data that refers to the railway as a noise source and is required and adequate to calculate noise indicators according to Annex 1, Section (1) of the Decree of the Government [9] with application of the calculation methods specified in the Guide of the NPI [11].

5.3.3 Geometry data

From the point of view of noise calculation, a railway consists of individual sections assigned a unique common identifier.
Sections have uniform sound-related properties (attributes) over their entire length. If one or more of these properties changes at a railway cross-section, there is a change in section.
A railway section can describe one or more parallel tracks, whereby the latter is only permitted if the distance to the nearest – also possible future – residential buildings is significantly greater than the distance of the outermost tracks. With regard to the inclusion of shielding objects, however, the separate inclusion of each track as a railway is to be preferred.
Railways are presented by the track axis described as polygon line or – if more than one track are included - their center axis of all tracks together. Preferably each track is presented separately by one polygon line.
The sections are assigned all of the attribute data stated below by means of unique identifiers.

The geometry data can be provided separately from the attribute data in one of the permitted geometry data formats if each data record has a unique identifier that is also used to identify the corresponding attribute data.

5.3.4 Property data

Each section is uniquely assigned all of the property data (attribute values) necessary for the sound-related description. Essentially, this is sound-related relevant information on

- the construction of the railway such as foundation, track connection and securing (both from a given list), design identifier such as grade crossing, bridge or curve
- the railside buildings such as mean distance and height of the closed façades bordering the railway at both sides
- the traffic flows such as speed, length and disc brake proportion of each train type as well as the number of movements separately for day, evening and night

The attribute data can be provided separately from the geometry data in one of the permitted database formats if each data record has a unique identifier that is also used to identify the corresponding geometry data.
The attribute data can be provided together with the geometry data in one of the permitted object description formats.

5.4 Industrial areas

5.4.1 Types

A distinction is to be made between industrial areas in an agglomeration area within the definition of the Law [8] and other industrial areas with a noise emission that can lead to relevant noise immission in one of these agglomeration areas. Only entire industrial areas with a size of at least 40,000 m² are taken into account.
Planned and approved but not yet fully built industrial areas as well as industrial areas that do not reach their permitted emission are taken into account accordingly with the maximum emission approved for their operation.

(Note: The noise immission of an industrial area is relevant if together with the noise immission from all other industries, it can lead to noise indicator values L_{den} > 50 dB and L_n > 45 dB at the nearest residential buildings. In all cases, it can be regarded as irrelevant if it alone leads to the noise indicator values L_{den} < 45 dB and L_n < 40 dB.

5.4.2 General

Within the framework of this law, industrial data are all data that refer to the industrial facility as a noise source and that are required and adequate to calculate noise indicators according to Annex 1, Section (1) of the Decree of the Government [9] with application of the calculation method specified in the Guide of the NPI [11].
As a general principle, industrial operations can be described as sound sources with different degrees of detail.

The complete description comprises the data of the buildings with their noise emission as well as other objects that influence the sound propagation, all outdoor sound sources as well as the traffic movements on the premises.

The simplified description simulates the noise emission of the industrial facility by one or more area sound sources parallel to the ground. The area sound sources cover the entire area of the industrial premises and have an emission – expressed as a area-related sound power level – that lead to the same value of the noise indicators L_{den} and L_n as they arise from the noise impact from the industrial facility itself at the nearest residential buildings if the noise immission is calculated according to the method specified in the Guide of the NPI [11]. The building and other shielding objects are not taken into account within the framework of this simplified description.
In the following, the simplified description is assumed.

5.4.3 Geometry data

The industrial facility simulated with area sound sources consists of one or more partial areas, represented by closed polygons with a relative height that corresponds to the focal point of the real sources or with height 0 above the ground.
The partial areas are assigned their emission data by mean of unique identifiers.
The geometry data can be provided separately from the attribute data in one of the permitted geometry data formats if each data record has a unique identifier that is also used to identify the corresponding attribute data.

5.4.4 Attribute data

Each industrial area or partial area is uniquely assigned all of the property data (attribute values) necessary for the sound-related description.
Essentially, this is the sound-related, relevant information on the emission or the A-weighted, area-related sound power level. A frequency-dependent representation is not required for the degree of detail of the simplified description.
The attribute data can be provided separately from the geometry data in one of the permitted database formats if each data record has a unique identifier that is also used to identify the corresponding geometry data.
The attribute data can be provided together with the geometry data in one of the permitted object description formats.

5.5 Aircraft noise data

5.5.1 Area of application

The following specifications regarding the data to be provided concern airports and airfields in an agglomeration area within the definition of the Law [8] and other airports and airfields with a noise emission that can lead to relevant noise immission in an agglomeration area.

(Note: The noise immission of an airport or airfield is relevant if, together with the noise immissions from all other airports and airfields, it can lead to noise indicator values L_{den} > 50 dB and L_n > 45 dB and if its own contribution is L_{den} > = 40 dB and/or L_n > = 35 dB.

5.5.2 General

Within the framework of the Law [8], aircraft noise data are all data that refer to the noise immission caused by flight operations near an airport as source and that are required and adequate to assess the noise indicators according to Annex 1, Section (1), of the Decree of the Government [9].
As a general principle, it is the duty of the operator of an airport or airfield in accordance with the above assignment to determine the noise emission and immission according to the specified method on the basis of the location of the runways as well as the flight paths and the flight movements that take place there. This noise immission data have to be passed to physical persons, companies and legal persons responsible for creating noise maps and action plans according to the Decree of the MoH [10].
If the airport or airfield has fewer than 1000 flight movements in a year and/or there is no regular air traffic, it is not considered. This also applies to airfields that are only used for flights to provide assistance in the case of accidents, for the transport of patients, for police missions as well as for other flights that serve the public interest.
If the airport or airfield has more than 1000 but fewer than 10,000 flight movements per year, if this is regular flight traffic and if its noise immission affects an agglomeration area, it must provide the authority responsible for strategic noise mapping in the agglomeration area with the information of the facility geometry and flight movements that is required to determine the noise immission in the territory of the agglomeration area according to the method specified in the Guide of the NPI [11].
If the airport or airfield has more than 10,000 and a maximum of 50,000 flight movements per year, if this is regular flight traffic and if its noise immission affects an agglomeration area, it must provide the authority responsible for strategic noise mapping in the agglomeration area with information regarding the immissions caused by the flight operations.
If the airport or airfield has more than 50,000 flight movements per year with regular flight traffic, then it is a major airport as defined by the Law [8] and the airport has to produce strategic noise maps and provide these to the NPI with information about the number of people affected and an action plan in accordance with the Law [8] and the Decree of the Government [9].

5.5.3 Information on the facility geometry and flight movements

This information is provided in a uniform manner in accordance with the Guide of the NPI [11].
It comprises
- the geometry data of each runway (reference point coordinates, direction, location of takeoff point and landing threshold,
- the geometry data of the landing and takeoff paths (corresponding runway, path segments consisting of straight sections and curves),
- the number of flight movements for each aircraft group specified in the calculation method separately for each flight path.

5.5.4 Information on the noise immission caused by flight operations - grid data

Within the boundaries specified for the agglomeration area, the noise indicators L_{den} and L_n calculated from flight operations and related to the specified grid of 10 m and a height of 4 m are determined and transferred in one of the permitted formats.

6 Guide of the national public health institute about the methods to calculate strategic noise maps

6.1 Purpose

The Law of the Government [8] was passed in order to implement EU Directive 2002/49/EC. The Decree of the Ministry of Health [10] defines the information or data to be provided by physical persons, companies and legal persons. The following section provides more concrete details of these specifications, indicating methods to be applied to the calculation and determination of this data.

6.2 Methods to determine noise immissions for strategic noise maps

The noise indicators are to be mainly determined using calculation, as this is the only way to represent the dependency of the noise immission on the source parameters and the only way that allows adaptation to changed parameter values.
Measurements are required as

- Calibration measurements to determine correction values for certain sources that have not yet been recorded so that these can be included in the specified calculation methods (country-specific road surfaces, railway types) and
- verification measurements to check at individual points whether the values determined using strategic noise maps are plausible.

6.2.1 Method for determining by calculation

Table 1 contains the guidelines and standards to be used for the calculation of noise indicators as well as the country-specific supplements and modifications to be taken into account for the individual noise types.

Table 1: Methods of noise calculation recommended for strategic noise mapping in Slovakia

Noise type / sound source	Standard / guideline	Country-specific supplement
Non-rail road traffic	Calculation method NMPB Routes 96 with French standard XPS 31-133 [12]*	Modifications of the calculation method NMPB Routes 96: Application in the Slovakian Republic to determine strategic noise maps [13]
Railways and rail-bound road traffic	The German method "Schall 03 – calculation of sound immission of rail tracks" [14]**	Modifications of the calculation method Schall 03: Application in the Slovakian Republic to determine strategic noise maps [15]
Industry, incl. inland shipping and port operations	ISO 9613-2 calculation of outdoor sound propagation [16]*	Modifications of the calculation specification ISO 9613-2: Application in the Slovakian Republic to determine strategic noise maps [17]
Air traffic	ECAC.CEAC Doc.29 [18]*	Modifications of the calculation specification ECAC.CEAC Doc.29: Application in the Slovakian Republic to determine strategic noise maps [19]

*http://forum.europa.eu.int/Public/irc/env/noisedir/library?l=/directive_200249/material_mapping/recommended_computation/reports_interim&vm=detailed&sb=Title
**VakuSchall03 “Richtlinie zur Berechnung der Schallimmissionen”, Source of supply: DB Services Technische Dienste GmbH, Kriegsstraße 1, 76131 Karlsruhe (Germany)

6.2.2 Determination by measurement

Calibration measurements at roads

If the influence of a certain road surface is unknown and roads with this surface are to be included in the calculation of strategic noise maps, this influence must be determined as a correction value.

A measuring position is selected at a straight part of the road with this surface and, as comparison, at a straight part of the road as similar as possible but with smooth poured asphalt at a distance of 7.5 m from the facing driving lane axis. The measurements are made without extraneous traffic. The SEL (Single Event Level) of the passing car with at least 3 various middle-class cars at 50 kph, 80 kph and 100 kph is determined, whereby each test is repeated at least 3 times.. The 9 values of the SEL for a speed are averaged for both measuring points separately. The difference of these mean values for asphalt and the road surface to be examined is the correction value for this surface. If the correction is to be determined independently of speed, the corrections related to different speeds are averaged again taking into account a weighting that represents the typical distribution of the driven speeds on that surface.

Calibration measurements at railways

To determine correction values for special ground conditions, track connections or train types.

Also for these measurements, the SELs (Single Event Levels) of individual passing trains are determined without the influence of extraneous noise. The measuring point is located preferably at a distance of 25 m to the track axis and at a height of 4 m above the upper edge of the track.

The same situation is modeled in a sound calculation program. For the daytime (16 h), 57,600 train movements are entered in the sound calculation program, whereby all the parameter are set to the values of the measured train. The difference between the calculated value and the measured SEL is the correction determined for this passing train.

Verification measurements

If sound measurements are to be carried out as verification of calculated values, mobile measurement stations measuring continuously with the possibility of multiple-day and unsupervised measurements are required. The duration of a measurement should be at least a full week with 7 days or a multiple of this period. The microphone height is preferably 4 m and the distance to the curb of the nearest road should not be less than 10 m. Measurement points that are significantly influenced by the noise of the strongest sound source in this area should be selected.

The measurement station should at least measure and record the hourly mean levels. Averaging over all the days results in the mean daily curve of the hourly mean level which can be used to calculate the noise indicator values L_{den} and L_{night} or also the values related to periods L_{day}, $L_{evening}$ and L_{night}. These can then be compared to the calculation results of the strategic noise map.

In this comparison, it should be taken into account that the calculation is based on the mean traffic data for the year and therefore deviations will have to be accepted that correspond to the fluctuations in the mean level values related to the week. This can only be avoided if traffic counts are carried out during the sound measurements and used to convert calculation results.

Adaptation measurements
Sound measurements made at main sources of noise can be used to adapt a calculated noise map to the current emission of this source. With a number of measurement stations, a 'dynamic noise map' can be created, and this adapted continuously to the measured values of the last day, for example.
To this end, continuous measurement stations are to be installed in the direct area of influence of the most important noise sources. For safety reasons, the microphone height should be approx.10 m and the distance to the facing driving lane of the dominating road should be approximately equal to double the road width.

6.3 The sources and immission zones to be involved

6.3.1 General

To determine the strategic noise maps as well as the information on the exposure of people, the noise indicators L_{den} and L_n are calculated in the agglomeration areas and in the area surrounding major roads, major railways and major airports in entire areas in the grid of 10 m and at a height of 4 m above ground. They are determined additionally at receiver points with 0.05 m distance from the most exposed and the quietest façade in a height of 4 m above ground. Houses where the difference between the noise indicators at the most exposed and the quietest façade is at least 22 dB are qualified as houses with a quiet façade.
Only in the case of aircraft noise is it permitted to calculate these levels at the façades from the interpolated grid data that have been determined without consideration of the shielding by houses.
In order to be able to perform these calculations, digital models of these areas are created.

6.3.2 Area boundary

Modeling agglomeration areas
The digital town model is created for the entire area of influence of the agglomeration area. The area of influence of the agglomeration area comprises the area outside the agglomeration area boundary up to a distance of 1000 m. Major roads, major railways, industrial areas as well as airports are also taken into account in determining the noise immission in the agglomeration area outside the boundary of the area of influence, independent of their distance to the agglomeration area, if they and the other sources of noise of the source type under examination can lead to noise indicator values $L_{den} > 50$ dB and $L_n > 45$ dB. In all cases, they can be regarded as irrelevant if they alone lead to the noise indicator values $L_{den} <$ 40 dB and $L_n < 35$ dB.

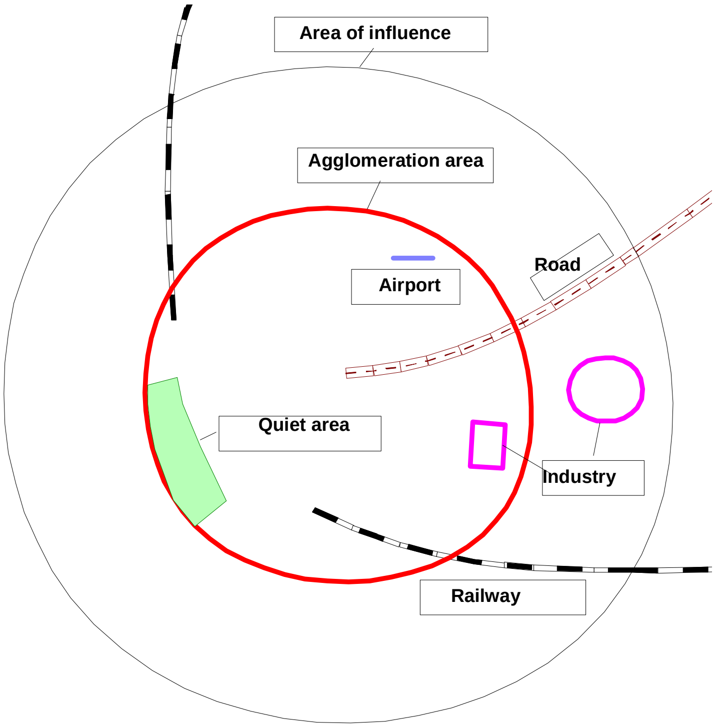

Figure 2: Scheme of sources influencing the agglomeration area

Roads in agglomeration areas
are to be taken into account in all cases if their mean daily traffic reaches or exceeds 5000 vehicles in 24 hours. The number of traffic movements is to be determined by suitable counts in the major road system and by creating a network model.
Roads with less traffic are classified according to their use.

Table 2: Reference values for subordinate roads according to use

Road type	**Cars/24 h**	**Proportio n of trucks**
Connecting roads between roads of the main network	2500	15 %
Roads feeding residential areas	1000	3 %
Roads feeding industrial areas	1000	10 %
Roads in residential areas without connecting function (e.g. with dead end)	500	0 %

The inclusion of roads with fewer than 5000 vehicles / 24 hours is not mandatory.

Railways in agglomeration areas
are taken into account if their average traffic volume over the entire year is regularly at least
- 5 trains daytime or
- 2 trains evenings or
- 1 train nighttime

Airports or airfields in agglomeration areas
are not taken into account if they
- have fewer than 1000 flight movements per year or

- are only used for flights to provide assistance in the case of accidents, for the transport of patients, for police missions as well as for other flights that serve public interests.

If the airport or airfield has fewer than 1000 flight movements in a year and/or there is no regular air traffic, it is not considered. This also applies to airfields that are only used for flights to provide assistance in the case of accidents, for the transport of patients, for police missions as well as for other flights that serve the public interest.
If the airport or airfield has more than 1000 but fewer than 10,000 flight movements per year, if this is regular flight traffic and if its noise immission affects an agglomeration area, it must provide the authority responsible for strategic noise mapping in the agglomeration area with the information of the facility geometry and flight movements that is required to determine the noise immission in the territory of the agglomeration area according to the method specified in the Guide of the NPI [11].
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If the airport or airfield has more than 50,000 flight movements per year with regular flight traffic, then it is a major airport as defined by the Law [8] and the airport has to produce strategic noise maps and provide these to the NPI with information about the number of people affected and an action plan in accordance with the Law [8] and the Decree of the Government [9].

Industrial facilities as well as industrial areas in agglomeration areas
Only industrially used, entire areas with more than 40,000 m² that cause environmental noise of L_{den} >= 50 dB and/or L_{night} >= 45 dB at their boundary are taken into account. In special cases with obviously high noise emission, the authority responsible for implementation of the law in the agglomeration area can also include companies on smaller premises.

Surveys of the noise indicator values L_{den} and L_{night} caused in the neighborhood are to be referred to control points at a distance of 3 m outside these area at a height of 4 m above ground (fence values). To create strategic noise maps, the industrial area with its actual construction is substituted by one or more – seamlessly adjoining – surface sound sources at a height of 4 m above ground, supplemented if required by other point and line sound sources. All information about these reference sound sources that lead to the values caused by the operation itself in the calculation of the noise indicators at the fence points using the specified method for industrial noise according to Table 1 within the framework of the possible accuracy is to be provided as information on the noise emission to the authority responsible for implementation of the law in the agglomeration area.

If there is only a single industrial enterprise on this area and it generates the noise indicator values $L_{den} < 50$ dB and $L_{night} < 45$ dB at the control points, it is ignored.

If there are a number of enterprises on this area and one of these facilities generates noise indicator values $L_{den} < 45$ dB and $L_{night} < 40$ dB at the control points, it is also ignored.

If the values stated are exceeded by the industrial enterprise, it must determine the complete data of its reference sound sources and make these available.

Data for point sound sources:
Coordinates x, y and z in the specified coordinate system

A-weighted sound power level L_{WA}

Data for line sound sources:
Coordinates of all polygon points x, y and z in the specified coordinate system
A-weighted length-related sound power level L'_{WA}

Data for area sound sources:
Coordinates of all corner points of the surrounding polygon x and y in the specified coordinate system (relative height 4 m)
A-weighted area-related sound power level L''_{WA}

Modeling outside agglomeration areas

In the vicinity of major roads, major railways and major airports, all areas are included in which the noise caused can lead to noise indicator values L_{den} > 50 dB and L_n > 45 dB.

Table 3: Calculation area around major roads

Major roads with DTV	**On each side, a strip of width**
< 20,000 vehicles / 24 hours	500 m
20,000 vehicles / 24 hours to 50,000 vehicles / 24 hours	750 m
Over 50,000 vehicles / 24 hours	1000 m

Table 4: Calculation area around major railways

Major railways with	**On each side, a strip of width**
up to 200 trains / 24 hours	500 m
200 to 400 trains / 24 hours	750 m
Over 400 trains / 24 hours	1000 m

For **major airports**, the calculation area is at least large enough that the curves with
L_{den} = 55 dB as well as L_{night} = 50 dB
can be recorded completely or that they hit the outer edges of a square with side length 40 km with the airport reference point as central point.

6.4 Creating the strategic noise maps

Strategic noise maps are calculated for the specified areas.
Starting point for the creation of strategic noise maps is a digital model of the surrounding area that meets all requirements. It must contain all the objects between sources and immission points that may significantly influence the sound propagation.

The reflection loss for the outer surfaces of the buildings is to be set to 1 dB, corresponding to an absorption coefficient of 0.21 independent of frequency.
All reflections of the 1st order that arise due to reflecting surfaces areas in a maximum distance of 50 m from the source or the immission point are to be included in the calculation. This also applies if the reflected ray is screened by other objects.

Screening is to be included according to the specified method. This also applies to screening ground undulations created by contours and elevated points.

The calculation is performed at immission points in the grid of 10 m and at a relative height of 4 m – the area-related noise maps are created by interpolation from the noise indicator values L_{den} and L_{night} determined there.

The colors specified below are to be used to represent the noise levels in the maps.

Table 5: Color scale for the level ranges to be represented

Noise range (dB)	**Color**	**RGB**
< 35	light green	85-190-71
35 to 40	green	0-114-41
40 to 45	dark green	15-77-42
45 to 50	yellow	228-228-0
50 to 55	ochre	171-162-0
55 to 60	orange	255-95-0
60 to 65	cinnabar	219-12-65
65 to 70	crimson	174-0-95
70 to 75	violet	146-73-158
75 to 80	blue	79-31-145
> 80	dark blue	33-18-101

6.5 Specifying quiet areas

Entire areas are specified where the following apply
L_{den} <= 45 dB
L_{night} <= 35 dB

6.6 Determining the area in which action plans are to be developed

Action plans are to be developed in the areas in which the noise indicators that describe the overall exposure reach or exceed the values
L_{den} = 65 dB and/or L_{night} = 55 dB

The noise map of the overall exposure is created from the strategic noise maps related to the individual noise types by adding up the levels. The outermost envelope of the areas that are limited by the lines of equal level for these two noise indicators is the surrounding boundary of the area in which measures are to be checked and action plans have to be developed.

6.7 Creating conflict plans

Conflict plans describe the areas in which the noise indicator values stated below are exceeded. For each of the sound source types roads, railways, airports, and industrial facilities, a conflict plan for this type of noise is to be created.

Table 6: Values of the source-specific noise indicators which represent a conflict if exceeded. L_{den} / L_{night} specified in dB.

Sources of noise	**Residential areas**	**Areas especially worthy to**

		be protected
Industry	55 / 40	50 / 35
Airports	62 / 52	62 / 52
Roads	60 / 50	55 /45
Railways	60 / 50	55 / 45

The following colors are to be used for representation in the conflict plan.

Table 7: Color scale for representation of conflict areas

Differential level (dB)	**Color**	**RGB**
< -5	white	255 – 255 - 255
-5 to 0	green	0 – 255 - 0
0 to 5	red	255 – 0 - 0
> 5	blue	0 – 0 - 255

6.8 Determining the information on noise exposure of inhabitants

Each residential building of the digital model is to be assigned the number of inhabitants. Moreover, the highest and lowest value of the noise indicators are determined separately for each residential building for each type of noise source.
This is done by calculating the noise indicators L_{den} and L_{night} at a distance of 0.05 m from all façades and at a height of 4 m, whereby at least one calculation point is required for each 10 m of façade length. The reflection at the calculation points own building is not included in this calculation. In all other points, the same requirements as stated for calculation of the strategic noise maps apply to the calculation of the noise indicators at the building façades.

If the difference between the highest and lowest value of each of the two noise indicators is at least 22 dB, the house is assigned the property "house with quiet façade" for that noise source type concerned.

For airport noise, the calculation of the noise indicators at the calculation points in front of the façades is not mandatory. As no screening is included in the calculation of aircraft noise and the values thus only change over greater distances, they can be adopted directly by interpolation from the strategic noise map.

The statistics concerning those affected are created using the number of inhabitants as well as the highest value of L_{den} and L_{night} for each residential building. The calculation is repeated with only the residential buildings with a quiet façade included.

7 Recommended methodologies – Investigations and selection process

7.1 Scope

According to the ToR of the project, one of the main topics – activity 2 – is the development of detailed methodologies for measurement and calculation of environmental noise.
Slovakia had no national calculation method for the sources road, railway, aircraft and industry. In this case the commission recommends in Annex II, 2.2 of Directive 2002/49/EC the use of the following methods:

For INDUSTRIAL NOISE: ISO 9613-2: "Acoustics – Abatement of sound propagation outdoors, Part 2: General method of calculation" [16].

For AIRCRAFT NOISE: ECAC.CEAC Doc. 29 "Report on Standard Method of Computing Noise Contours around Civil Airports",1997 [19] . Of the different approaches to the modelling of flight paths, the segmentation technique referred to in section 7.5 of ECAC.CEAC Doc. 29 will be used.

For ROAD TRAFFIC NOISE: The French national computation method "NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB)" [12],referred to in "Arrete du 5 mai 1995 relatif au bruit des infrastructures routieres, Journal Officiel du 10 mai 1995, Article 6" and in the French standard "XPS 31-133". For input data concerning emission, these documents refer to the "Guide du bruit des transports terrestres, fascicule prevision des niveaux sonores, CETUR 1980".

For RAILWAY NOISE. The Netherlands national computation method published in "Reken- en Meetvoorschrift Railverkeerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20 November 1996" [20].

An important part of this PHARE-project was to investigate the applicability of these methods under Slovak conditions. Generally it is possible

- to adapt an interim computation method without any modification
- to adapt an interim computation method with some modifications that take into account Slovakian conditions or to avoid shortcomings included in these methods
- to withdraw the interim computation method and to use an alternative as national method. Such a method should be comparable with the defined Interim method.

It was clear that such a decision for road and railway – the two major sources – must be based on investigations including measurements. The issue of this part of the project was to select a standard and to derive the necessary adaptions to Slovakian conditions. The measurement procedures are described in the Inception Report July 2004 [21].

7.2 Roads

7.2.1 Decision strategy

The method recommended to be used in countries with no accepted or compulsory national method is the French calculation method NMPB-Routes-96.
To decide about the applicability of the method in Slovakia and especially in Bratislava and to reach acceptance by the responsible authorities some measurements have been carried out. The same situation was modelled and the levels where calculated using the method under test. The deviation of calculated levels from those measured is an indicator for the accuracy of the method under given conditions.
Two types of measurements where used:

- sound pressure level during pass by of a single car – defined by the SEL
- equivalent sound pressure level with usual traffic flow, but with registration of all parameters necessary for a calculation of the same scenery.

7.2.2 Measurement with usual traffic

As an example measurements of the hourly LAFm values during 24 hours shall be reported. The situation with three microphone positions is shown in Figure 3.

Figure 3: Measurement positions with parallel registration of hourly Leq levels

All parameters necessary to calculate the sound pressure levels with NMPB and with RLS-90 have been registrated. The same situation was modelled and the levels have been calculated for each of these 24 hours separately using the two standards.
Table 6 shows the deviations calculated – measured levels. The differences are quite small and from the result it can be concluded that NMPB is the better approximation of reality in this case.

Table 8: Deviations calculated – measured levels

Time	NMPB: Deviation dB			RLS-90: Deviation dB		
	A	B	C	A	B	C
12.30 - 13.00	0.8	1.9	2.6	2.6	2.6	2.6
13.00 - 14.00	0.9	1.7	1.9	1.9	1.9	1.9
14.00 - 15.00	1.8	2.5	2.7	2.7	2.7	2.7
15.00 - 16.00	2.7	3.5	3.5	3.5	3.5	3.5
16.00 - 17.00	2.3	3.1	3.3	3.3	3.3	3.3
17.00 - 18.00	0.8	1.9	2.1	2.1	2.1	2.1
18.00 - 19.00	1.0	1.8	2.0	2.0	2.0	2.0
19.00 - 20.00	0.9	1.8	2.0	2.0	2.0	2.0
20.00 - 21.00	0.0	1.2	1.5	1.5	1.5	1.5
21.00 - 22.00	0.2	1.4	1.6	1.6	1.6	1.6
22.00 - 23.00	0.8	1.7	2.0	2.0	2.0	2.0
23.00 - 00.00	0.3	0.8	1.0	1.0	1.0	1.0
00.00 - 01.00	-0.7	-0.2	-0.2	-0.2	-0.2	-0.2
01.00 - 02.00	2.9	3.2	3.2	3.2	3.2	3.2
02.00 - 03.00	1.9	1.9	1.9	1.9	1.9	1.9
03.00 - 04.00	-1.6	1.4	1.4	1.4	1.4	1.4
04.00 - 05.00	1.3	2.4	2.6	2.6	2.6	2.6
05.00 - 06.00	2.4	3.7	4.0	4.0	4.0	4.0
06.00 - 07.00	0.3	1.3	1.5	1.5	1.5	1.5
07.00 - 08.00	0.8	1.7	1.8	1.8	1.8	1.8
08.00 - 09.00	1.1	1.6	1.8	1.8	1.8	1.8
09.00 - 10.00	0.8	1.4	1.6	1.6	1.6	1.6
10.00 - 11.00	1.8	2.3	2.5	2.5	2.5	2.5
11.00 - 12.00	1.2	1.8	2.0	2.0	2.0	2.0
Mean	**1.0**	**1.9**	**2.1**	**2.1**	**2.1**	**2.1**

With following assumptions
A heavy vehicles are only trucks
B heavy vehicles are trucks and buses
C heavy vehicles are trucks, buses and trolley-buses

Many other measurements show similar results. From all these investigations it can be concluded:

- the calculation overestimates the levels by about 2 dB
- the results with NMBP and with RLS-90 are comparable
- it is not important if buses and trolleys are qualified as heavy or light vehicles

7.2.3 Pass-by-Measurements with controlled conditions

With single pass-by-measurements it is possible to control the conditions like speed of the car very precisely. Using the same measurement at roads with different surfaces this surface influence can be investigated.
The disadvantage is clearly the dependence on car and tyre type – many measurements are necessary to investigate the influence of a road surface on the typical mix of car types.

Some of these measurements have been carried out to detect severe problems – if there are some – when the levels are compared with calculated ones.

Figure 4: Road where pass-by-measurements with controlled conditions have been made

Table 9: Results at position 1 – surface Asphaltobeton old and partly demolished

Car	30 km/h				50 km/h				100 km/h			
	1	2	3	mean	1	2	3	mean	1	2	3	mean
Octavia Fuel	68.4	68.2	69.5	68.7	74.7	74.0	74.2	74.3	82.3	82.3	82.1	82.2
Octavia Diesel	69.6	68.7	68.8	69.1	74.9	75.1	74.8	74.9	82.5	82.5	82.9	83.0
Opel Omega	70.2	69.4		69.8	75.3	74.9		75.1	82.3	82.8	82.6	82.6
			mean	69.2			mean	74.8			mean	82.6

Table 10: Results at position 2 – surface Asphaltobeton new

Car	30 km/h				50 km/h				100 km/h			
	1	2	3	mean	1	2	3	mean	1	2	3	mean
Octavia Fuel	68.1	68.2	67.3	67.9	75.0	74.7		74.9	82.0	82.0		82.0
Octavia Diesel	69.0	70.7	70.8	70.2	75.9	75.4		75.7	82.5	82.5		82.5
Opel Omega	70.8	69.4		70.2	75.3	75.2		75.3	81.8	82.1		82.0
			mean	69.6			mean	75.3			mean	82.2

Table 11: Statistical evaluation – results of all pass-by-measurements

v km/h	30	50	100
SEL measured	69.4	75.1	82.4
L calc (RLS)	72.5	74.3	81.2
L calc (NMPB)	72.2	73.5	79.9
d RLS	3.2	-0.3	-1.2
d NMPB	2.8	-1.2	-2.5

These results show a slight better approximation of reality when RLS-90 is used to calculate the levels. On the other side the differences are so small that they should not be used to decide for one or the other method.

As a final result it can be stated:
From the comparisons of measured and calculated sound pressure levels no reason has been found why the recommended Interim method NMPB should not be used. It is easy to include corrections for new road surfaces and to adept the method to new conditions.

A little disadvantage is the relatively complex influence of different parameters in NMPB – this makes it complicated to control unexpected results with simple and transparent “hand-calculations”. But this is a general problem – most developers tend to use the raising computer efficiency and make the calculation strategies more and more complex. It is the authors opinion that this will reduce the overall accuracy instead of improving it.

7.3 Railway

7.3.1 Measurement setup

Pass-by-measurements have been undertaken in accordance to the specification in the Inception report [21]. Modelling and calculation of this same situation and determination of difference calculation – measurement based on the standards SRMII and Schall03 give a deep insight in the individual differences and on the deviation of the calculated L_{eq} levels. These measurements have been carried out at different locations – as an example one of these situations is described in the following.

A straight railway track was selected with free sound propagation between track and the microphone in 25 m distance and 4 m height.

Figure 5: Position for measurements at straight railway track

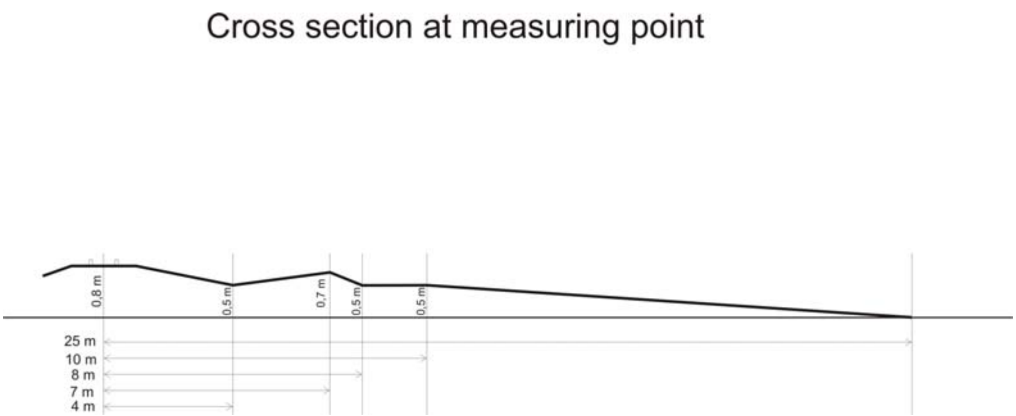

Figure 6: Cross section railway track – measuring position

For each train measurement the spectral and overall sound pressure levels L_{AF} were saved all 125 milliseconds. The plot of these levels versus time show the time dependent signal at the microphone position. For each pass-by a time interval was defined where the signal to background ratio was large enough to get sound emission information undisturbed by background noise.
By integration the average Level L_{AFm} related to the time interval T was determined from all 0.125 sec. samples.
From track and all trains all parameters have been registered that are needed to calculate this same average level L_{AFM} with standards SRMII and Schall03.
For the situation shown in Figure 5 and Figure 6 a computer model was created – this allows to calculate the levels during pass-by of any train and with the defined properties of the track.

7.3.2 Measurements results

1 Express Train Ex 120, 11-50
Electric block braked passenger train, 8 carriages including the locomotive HDV 163
Total mass - 570 t, total length - 216 m.
Real train speed - 81 km/h

Figure 7: Measured LAF levels – Leq = 76,6 dB(A) with T = 35,6 s (1618 trains/16h)

SRMII – 80,3 dB(A)
Schall03 – 79,3 dB(A)

2 Slow train Os 7855, 11-06
Electric block braked passenger train, 6 carriages including the locomotive HDV 162
Total mass - 350 t, total length - 139 m
Real train speed - 87 km/h

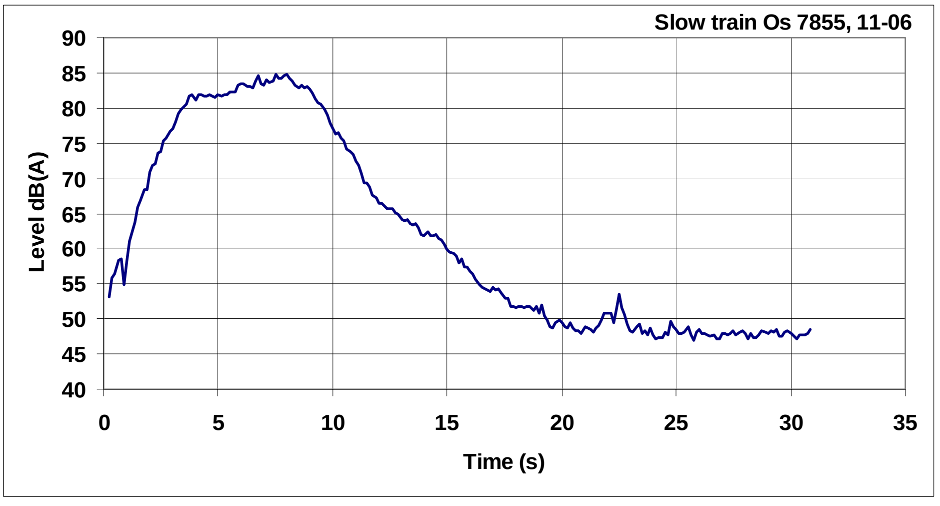

Figure 8: Measured LAF levels – Leq = 76,3 dB(A) with T = 30,9 s

SRMII – 80,0 dB(A)
Schall03 –80,9 dB(A)

3 Slow train Os 7855, 11-06
Electric block braked passenger train, 6 carriages including the locomotive HDV 162
Total mass - 350 t, total length - 139 m
Real train speed - 88 km/h

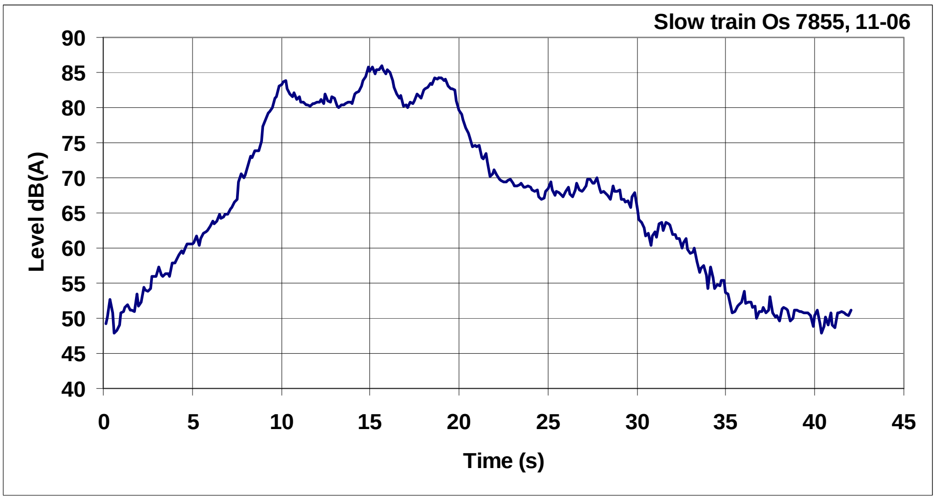

Figure 9: Measured LAF levels – Leq = 77,1 dB(A) with T = 42 s

SRMII – 78,8 dB(A)
Schall03 – 79,6 dB(A)

4 Slow train Os 7853, 09-10
Electric block braked passenger train, 6 carriages including the locomotive HDV 162
Total mass - 350 t, total length - 164 m
Real train speed - 97 km/h

Figure 10: Measured LAF levels – Leq = 75,8 dB(A) with T = 28 s

SRMII – 81,6 dB(A)
Schall03 – 83 dB(A)

5 Slow train Os 7839, 15-20
Electric block braked passenger train, 5 carriages including the locomotive HDV 162
Total mass - 350 t, total length - 139 m
Real train speed - 86 km/h

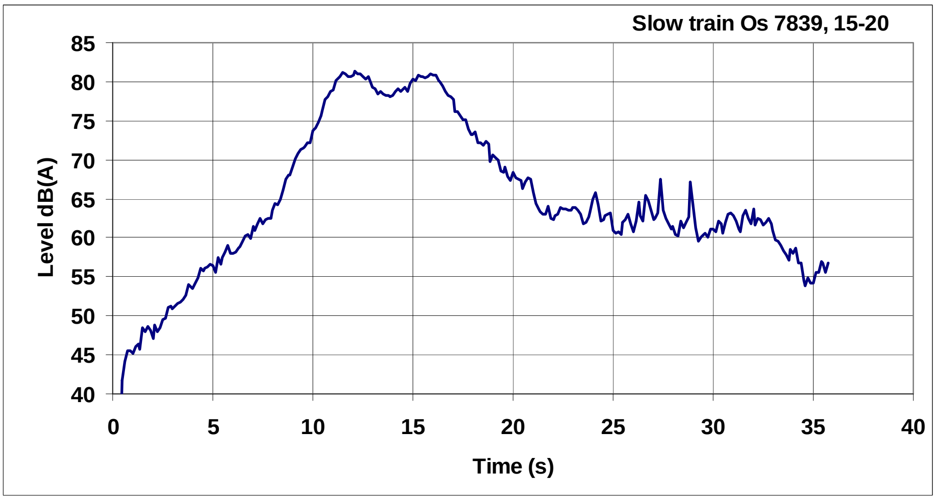

Figure 11: Measured LAF levels – Leq = 73,2 dB(A) with T = 35,8 s

SRMII – 79,2 dB(A)
Schall03 – 80,1 dB(A)

6 Slow train Os 7832, 08-24
Electric block braked passenger train, 5 carriages including the locomotive HDV 162
Total mass - 350 t, total length - 139 m
Real train speed - 84 km/h

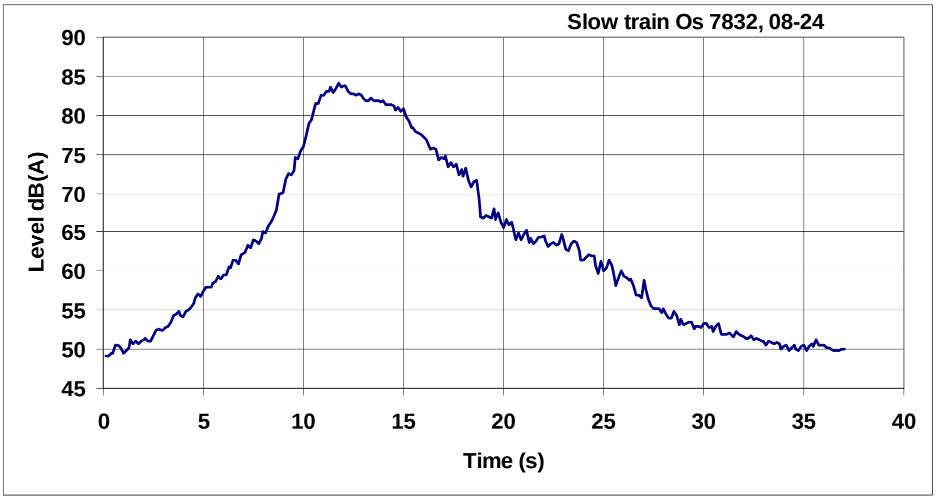

Figure 12: Measured LAF levels – Leq = 74,4 dB(A) with T = 37 s

SRMII – 78,8 dB(A)
Schall03 – 79,8 dB(A)

7 InterCity IC 405, 12-09

Electric block braked passenger train, 7 carriages including the locomotive HDV 350
Total mass - 400 t, total length - 189 m
Real train speed - 87 km/h

Figure 13: Measured LAF levels – Leq = 71,5 dB(A) with T = 36 s

SRMII – 73,9 dB(A)
Schall03 – 74,9 dB(A)

8 InterCity IC 404, 16-18
Electric block braked passenger train, 6 carriages including the locomotive HDV 350
Total mass - 400 t, total length - 164 m.
Real train speed - 91 km/h

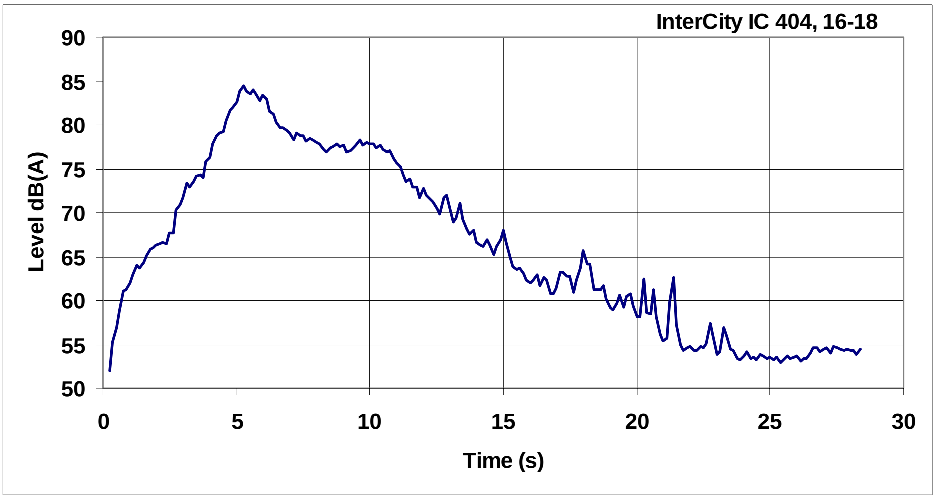

Figure 14: Measured LAF levels – Leq = 74,5 dB(A) with T = 28,4 s

SRMII – 74,5 dB(A)
Schall03 – 75,4 dB(A)

9 InterCity IC 404, 16-18
Electric block braked passenger train, 6 carriages including the locomotive HDV 350

Total mass - 400 t, total length - 164 m.
Real train speed - 92 km/h

Figure 15: Measured LAF levels – Leq = 74,4 dB(A) with T = 31,0 s

SRMII – 74,2 dB(A)
Schall03 – 75,1 dB(A)

10 Fast Train R 609

Electric block braked passenger train, 9 carriages including the locomotive HDV 350
Total mass - 610 t, total length - 281 m.
Real train speed - 100 km/h

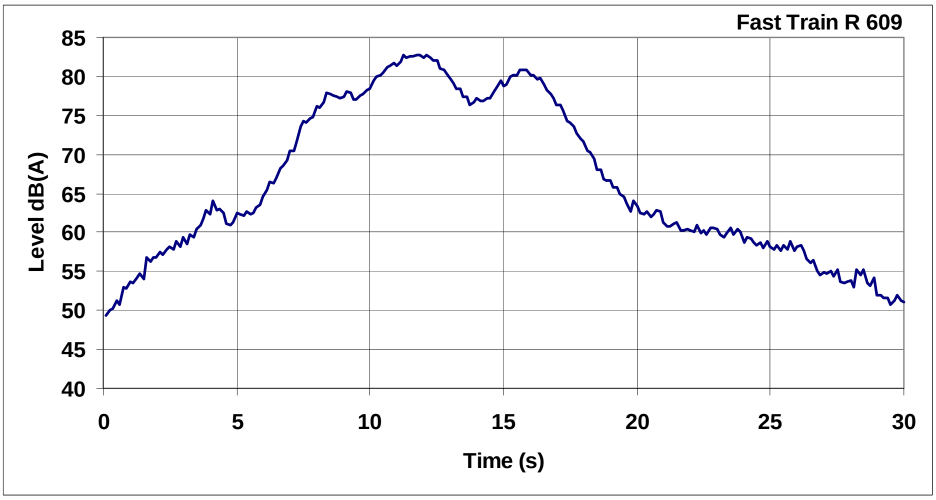

Figure 16: Measured LAF levels – Leq = 75,0 dB(A) with T = 30,0 s

SRMII – 75,4 dB(A)
Schall03 – 78,3 dB(A)

11 Fast Train R 607

Electric block braked passenger train, 9 carriages including the locomotive HDV 362 ČD
Total mass - 610 t, total length - 243 m.
Real train speed - 100 km/h

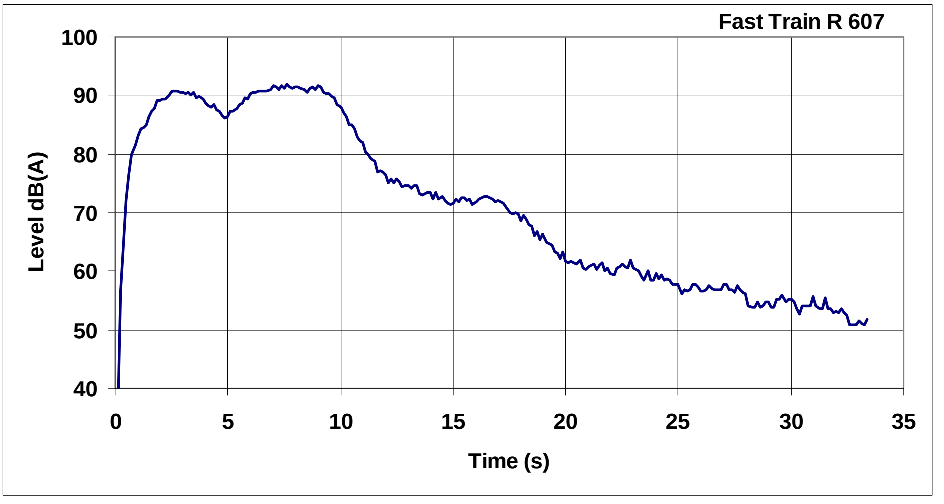

Figure 17: Measured LAF levels – Leq = 84,5 dB(A) with T = 33,4 s

SRMII – 83,3 dB(A)
Schall03 – 83,3 dB(A)

12 Fast Train R 605

Electric block braked passenger train, 10 carriages including the locomotive HDV 362
Total mass - 610 t, total length - 273 m.
Real train speed - 101 km/h

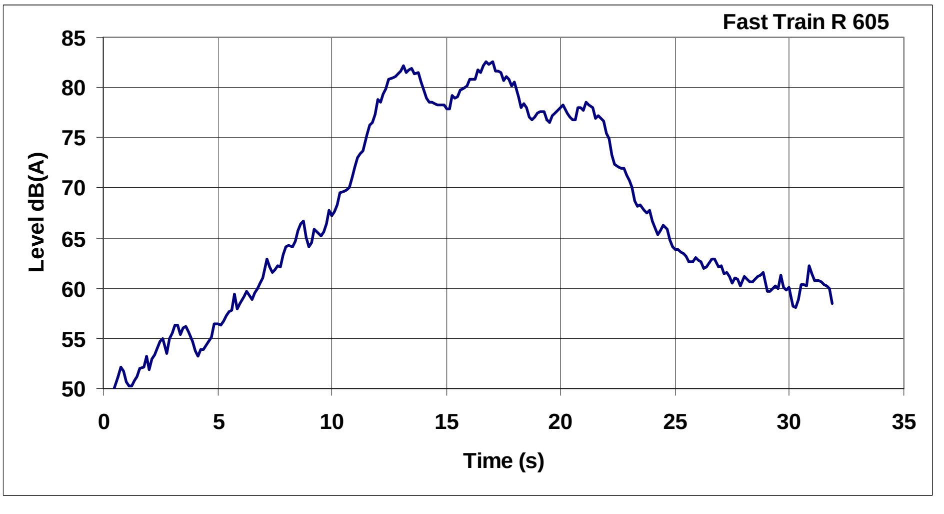

Figure 18: Measured LAF levels – Leq = 75,0 dB(A) with T = 31,9 s

SRMII – 75,6 dB(A)
Schall03 – 78,0 dB(A)

13 Fast Train R 605

Electric block braked passenger train, 10 carriages including the locomotive HDV 362
Total mass - 610 t, total length - 273 m.
Real train speed - 103 km/h

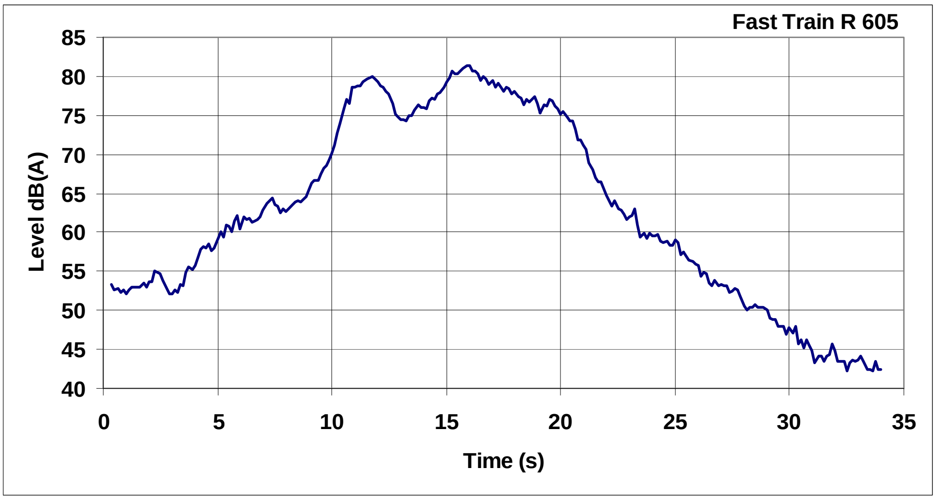

Figure 19: Measured LAF levels – Leq = 73,1 dB(A) with T = 34 s

SRMII – 75,5 dB(A)
Schall03 – 77,9 dB(A)

14 Express Train Ex 511, 16-14

Electric block braked passenger train, 10 carriages including the locomotive HDV 362
Total mass - 570 t, total length - 266 m.
Real train speed - 100 km/h

Figure 20: Measured LAF levels – Leq = 75,1 dB(A) with T = 33 s

SRMII – 75,4 dB(A)
Schall03 – 77,6 dB(A)

15 Fast Train R 421

Electric block braked passenger train, 12 carriages including the locomotive HDV 163 - ČD

Total mass - 610 t, total length - 311 m.
Real train speed - 101 km/h

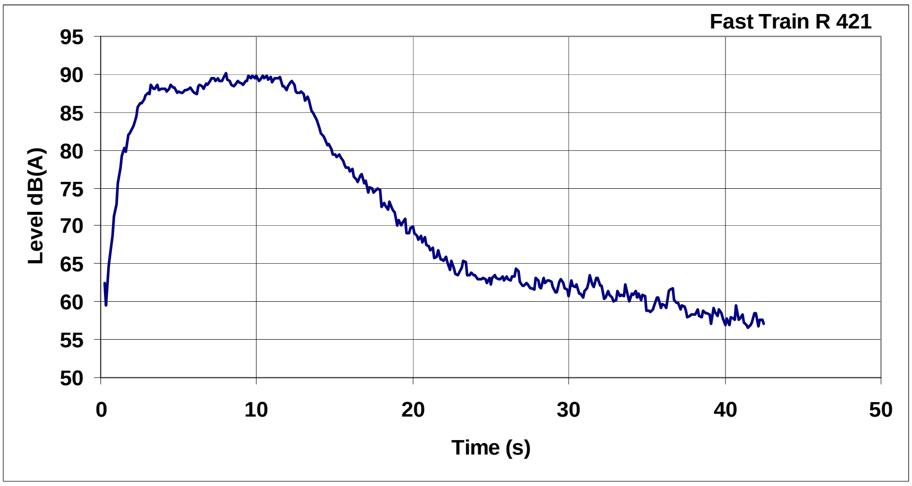

Figure 21: Measured LAF levels – Leq = 83,1 dB(A) with T = 42,5 s

SRMII – 83,3 dB(A)
Schall03 – 84,3 dB(A)

16 Local express freight train Zn 51552 14-38

Block braked freight train, wagons total - 35:
14 high-walled wagons - 14 loaded
21 opened wagons - 19 loaded
0 sheltered wagons
0 tank wagons

Total mass - 2048 t, load 1203 t, number of axles - 142, total length - 629 m.
Mass of braked wagons - 1749 t
Real train speed - 63 km/h

Figure 22: Measured LAF levels – Leq = 79,0 dB(A) with T = 52,6 s
1095 trains/16h – 38327 carriages/16h

SRMII – 84,0 dB(A)

Schall03 – 82,3 dB(A)

17 Local express freight train Zn 51750 08-04
Block braked freight train, wagons total - 37:
21 high-walled wagons - 21 loaded
11 opened wagons - 1 loaded
2 sheltered wagons - 2 loaded
3 tank wagons - empty
Total mass - 1943 t, load 1125 t, number of axles - 148, total length - 591 m.
Mass of braked wagons - 1490 t
Real train speed - 69 km/h

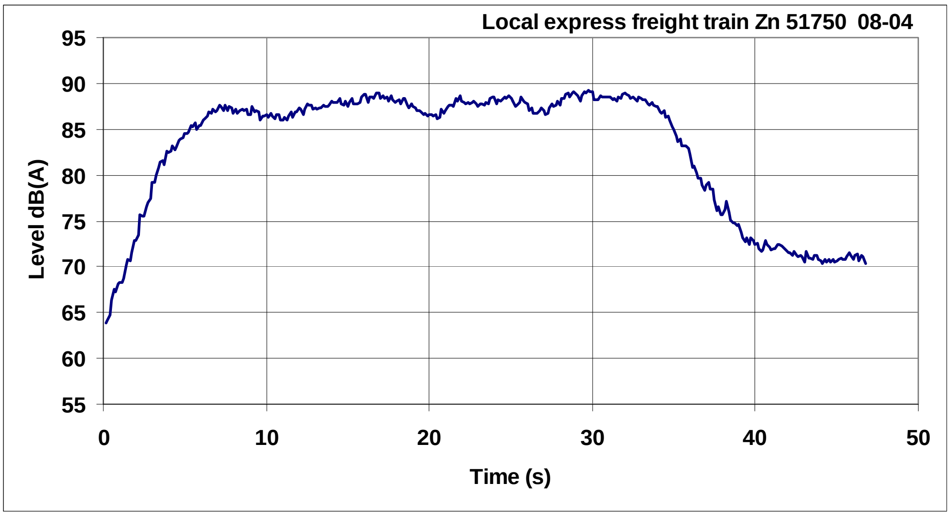

Figure 23: Measured LAF levels – Leq = 85,9 dB(A) with T = 46,8 s
1231 trains/16h – 45538 carriages/16h

SRMII – 83,1 dB(A)
Schall03 – 83,3 dB(A)

18 Local express freight train Zn 55163, 14-53
Block braked freight train, wagons total - 29:
24 high-walled wagons - empty
5 opened wagons - empty
0 sheltered wagons
0 tank wagons
Total mass - 749 t, load 0 t, number of axles - 116, total length - 423 m.
Mass of braked wagons - 719 t
Real train speed - 70 km/h

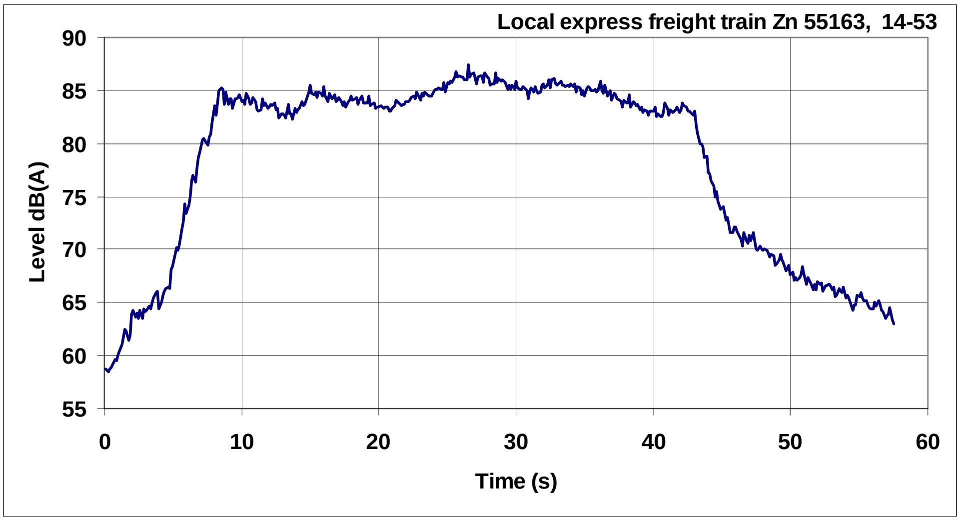

Figure 24: Measured LAF levels – Leq = 82,6 dB(A) with T = 57,5 s
1002 trains/16h – 29050 carriages/16h

SRMII – 83,8 dB(A)
Schall03 – 81,1 dB(A)

19 Local express freight train Zn 55171 08-40

Block braked freight train, wagons total - 32:

1 high-walled wagons - empty
3 opened wagons - 3 loaded
25 sheltered wagons - 19 loaded
3 tank wagons - empty

Total mass - 1600 t, load 874 t, number of axles - 120, total length - 525 m.
Mass of braked wagons - 1211 t
Real train speed - 62 km/h

Figure 25: Measured LAF levels – Leq = 76,9 dB(A) with T = 41,3 s
1395 trains/16h – 46024 carriages/16h

SRMII – 84,6 dB(A)
Schall03 – 82,4 dB(A)

20 Local express freight train Zn 57153, 17-28

Block braked freight train, wagons total - 42:

6 high-walled wagons - 2 loaded
26 opened wagons - 4 loaded
4 sheltered wagons - 3 loaded
5 tank wagons - 1 loaded
1 different wagon

Total mass - 1108 t, load 178 t, number of axles - 148, total length - 643 m.
Mass of braked wagons - 1108 t
Real train speed - 77 km/h

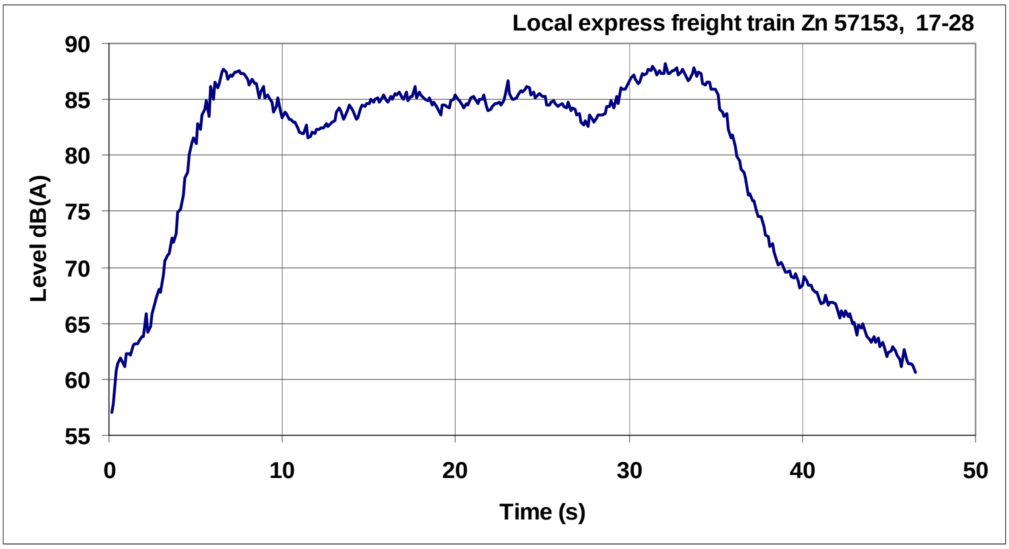

Figure 26: Measured LAF levels – Leq = 83,6 dB(A) with T = 46,5 s
1239 trains/16h – 53264 carriages/16h

SRMII – 87,3 dB(A)
Schall03 – 84,7 dB(A)

21 Through freight train Pn 48770 14-19

Block braked freight train, 31 high-walled wagons
Total mass - 2412 t, load 1699 t, number of axles - 124, total length – 434 m.
Mass of braked wagons - 1540 t
Real train speed - 56 km/h

Figure 27: Measured LAF levels – Leq = 81,9 dB(A) with T = 48,4 s
1190 trains/16h – 38083 carriages/16h

SRMII – 82,9 dB(A)
Schall03 – 80,0 dB(A)

22 Through freight train Pn 49738 11-27

Block braked freight train, 33 high-walled wagons
Total mass - 2404 t, load 1668 t, number of axles - 130, total length - 458 m.
Mass of braked wagons - 1650 t
Real train speed - 56 km/h

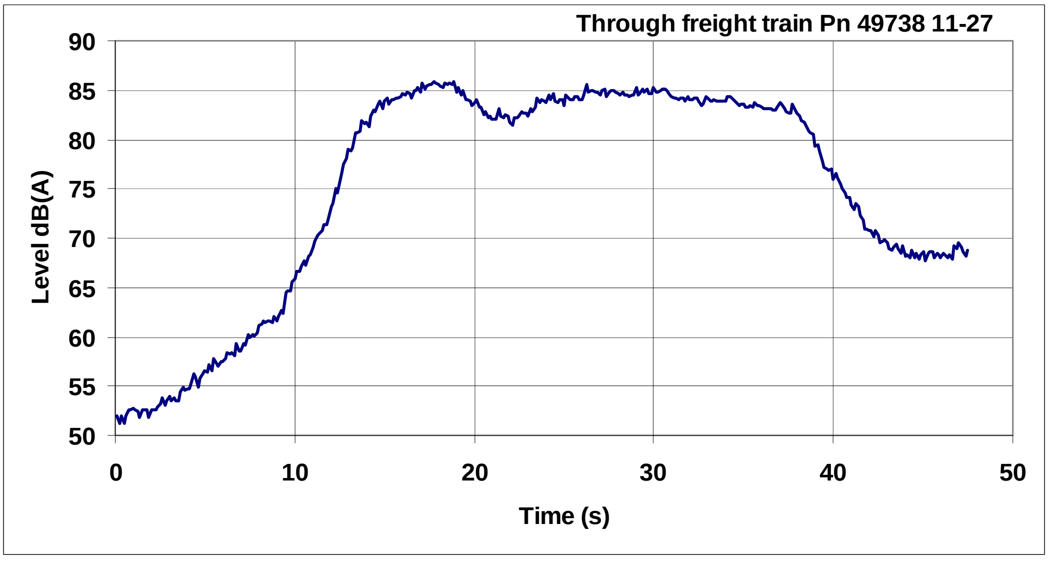

Figure 28: Measured LAF levels – Leq = 79,7 dB(A) with T = 47,5 s
1213 trains/16h – 41229 carriages/16h

SRMII – 83,3 dB(A)
Schall03 – 80,4 dB(A)

23 Through freight train Pn 48745 11-30

Block braked freight train, 31 high-walled wagons
Total mass - 2483 t, load 1780 t, number of axles - 124 total length - 434 m.
Mass of braked wagons - 1496 t
Real train speed - 54 km/h

Figure 29: Measured LAF levels – Leq = 76,9 dB(A) with T = 51,8 s
1112 trains/16h – 35583 carriages/16h

SRMII – 79,1 dB(A)
Schall03 – 79,4 dB(A)

24 Through freight train Pn 49753 12-31

Block braked freight train, 25 high-walled wagons
Total mass - 1995 t, load 1420 t, number of axles - 100, total length - 350 m.
Mass of braked wagons - 1256 t
Real train speed - 56 km/h

Figure 30: Measured LAF levels – Leq = 78,8 dB(A) with T = 48,0 s
2215 trains/16h – 57600 carriages/16h

SRMII – 82,1 dB(A)
Schall03 – 79,1 dB(A)

25 Through freight train Pn 49757 15-41

Block braked freight train, 31 high-walled wagons
Total mass - 2481 t, load 1766 t, number of axles - 124, total length - 434 m.
Mass of braked wagons - 1508 t
Real train speed - 62 km/h

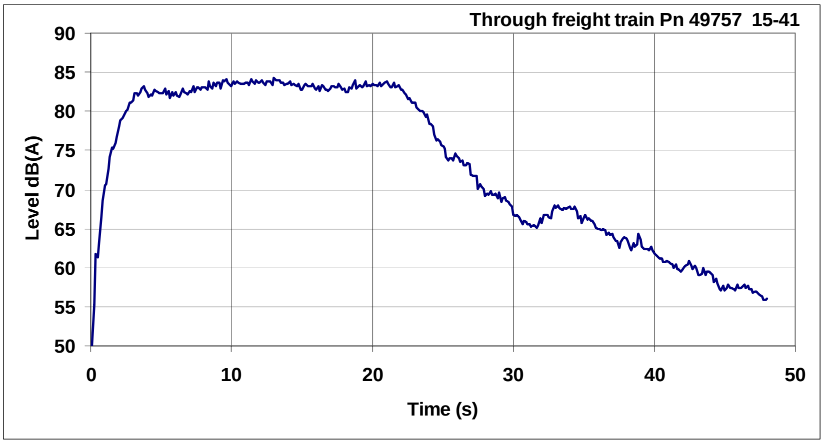

Figure 31: Measured LAF levels – Leq = 79,7 dB(A) with T = 48,0 s
1200 trains/16h – 38400 carriages/16h

SRMII – 83,8 dB(A)
Schall03 – 81,0 dB(A)

26 Way freight train Mn 85572 14-45

Block braked freight train, wagons total - 10:

4 high-walled wagons - empty
4 opened wagons - 1 loaded
0 sheltered wagons
1 tank wagons - empty
1 different wagon

Total mass - 223 t, load 4 t, number of axles - 38, total length - 161 m.
Mass of braked wagons - 223 t
Real train speed - 44 km/h

Figure 32: Measured LAF levels – Leq = 75,1 dB(A) with T = 43,6 s
1321 trains/16h – 14532 carriages/16h

SRMII – 76,8 dB(A)
Schall03 – 74,1 dB(A)

27 Way freight train Mn 85572 15-2
Block braked freight train, wagons total - 2:
0 high-walled wagons
1opened wagons - 1 loaded
0 sheltered wagons
0 tank wagons
1 different wagon
Total mass - 82 t, load 44 t, number of axles - 6, total length - 31 m.
Mass of braked wagons - 76 t
Real train speed - 53 km/h

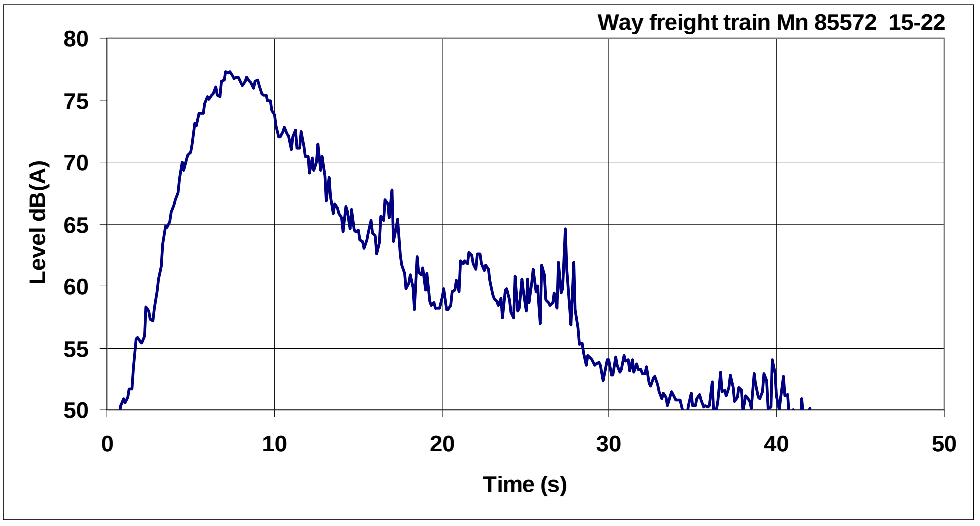

Figure 33: Measured LAF levels – Leq = 68,1 dB(A) with T = 42,0 s
1371 trains/16h – 414 carriages/16h

SRMII – 72,8 dB(A)
Schall03 – 68,7 dB(A)

28 Way freight train Mn 85573 17-22
Block braked freight train, wagons total - 12:
3 high-walled wagons - 2 loaded
6 opened wagons - 2 loaded
2 sheltered wagons - 1 loaded
0 tank wagons
1 different wagon
Total mass - 403 t, load 156 t, number of axles - 40, total length - 192 m.
Mass of braked wagons - 370 t
Real train speed - 51 km/h

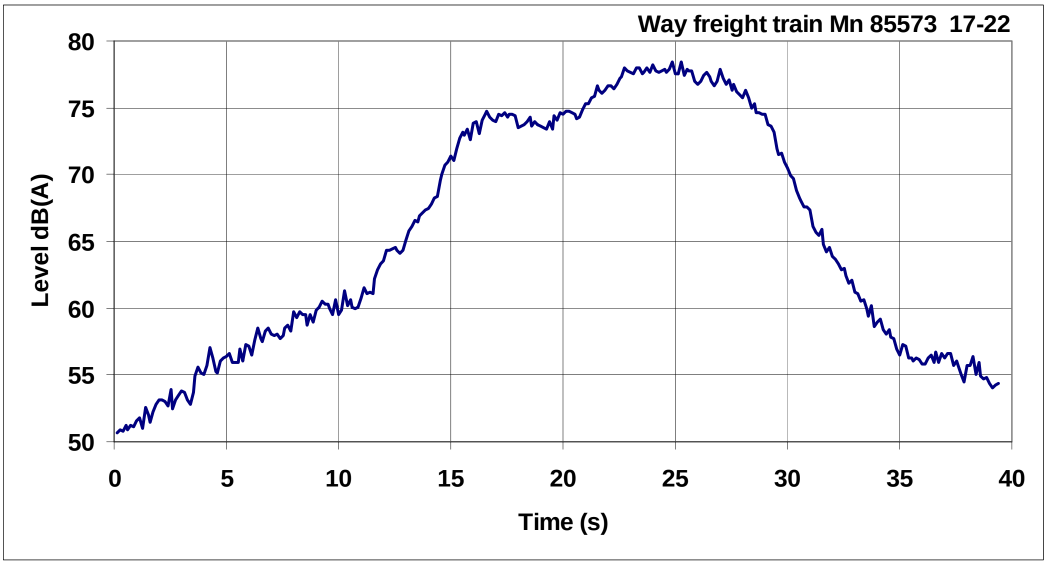

Figure 34: Measured LAF levels – Leq = 71,9 dB(A) with T = 39,4 s
1462 trains/16h – 19005 carriages/16h

SRMII – 79,1 dB(A)
Schall03 – 76,6 dB(A)

29 Way freight train Mn 85573, 17-31

Block braked freight train, wagons total - 26:

11 high-walled wagons - empty
12 opened wagons - empty
2 sheltered wagons - empty
0 tank wagons
1 different wagon

Total mass - 534 t, load 0 t, number of axles - 90, total length - 415 m.
Mass of braked wagons - 512 t
Real train speed - 58 km/h

Figure 35: Measured LAF levels – Leq = 68,8 dB(A) with T = 29,3 s
1966 trains/16h – 53078 carriages/16h

SRMII – 75,1 dB(A)
Schall03 – 71,1 dB(A)

7.3.3 Assessment and conclusions

62 complete pass-by-scenarios have been included in this investigation – 29 of them are reported above. In Table 12 the values L(S03) and L(SRM) have been calculated, the value Leq was measured.

Table 12: Statistical analysis of deviations

Train	Leq dB(A)	SEL dB(A)	L(S03) dB(A)	L(SRM) dB(A)	d_S03 dB	d_SRM dB
1_Express	76.6	92.1	79.3	80.3	2.7	3.7
14_Express	75.1	90.3	77.6	75.4	2.5	0.3
15_Fast R421	83.1	99.4	84.3	83.3	1.2	0.2
13_Fast 13-06	73.1	88.4	77.9	75.5	4.8	2.4
12_Fast 13-10	75.0	90.0	78.0	75.6	3.0	0.6
11_Fast R607	84.5	99.7	83.3	83.3	-1.2	-1.2
10_Fast 17-04	75.0	89.8	78.3	75.4	3.3	0.4
9_IC 404 16-18	74.4	89.3	75.1	74.2	0.7	-0.2
8_IC 404 16-24	74.5	89.0	75.4	74.5	0.9	0.0
7_IC 405 12-09	71.5	87.1	74.9	73.9	3.4	2.4
16_Freight 14-38	79.0	96.2	82.3	84.0	3.3	5.0
17_Freight 08-04	85.9	102.6	83.3	83.1	-2.6	-2.8
18_Freight 14-53	82.6	100.2	81.1	83.8	-1.5	1.2
19_Freight 08_40	76.9	93.1	82.4	84.6	5.5	7.7
20_Freight 17-28	83.6	100.3	84.7	87.3	1.1	3.7
6_Slow 8-24	74.4	90.1	79.8	78.8	5.4	4.4
5_Slow 15-20	73.2	88.7	80.1	79.2	6.9	6.0
4_Slow 9-10	75.8	90.3	83.0	81.6	7.2	5.8
3_Slow 11-06	77.1	93.3	79.6	78.8	2.5	1.7
2_Slow 11-12	76.3	91.2	80.9	80.0	4.6	3.7
21_T-Freight 14-19	81.9	98.7	80.0	82.9	-1.9	1.0
22_T-Freight 11-27	79.7	96.5	80.4	83.3	0.7	3.6
23_T-Freight 11-30	76.9	94.0	79.4	79.1	2.5	2.2
24_T-Freight 12-31	78.8	95.6	79.1	82.1	0.3	3.3
25_T-Freight 15-41	79.7	96.5	81.0	83.8	1.3	4.1
26_W-Freight 14-45	75.1	91.5	74.1	76.8	-1.0	1.7
27_W-Freight 15-22	68.1	84.3	68.7	72.8	0.6	4.7
28_W-Freight 17-22	71.9	87.9	76.6	79.1	4.7	7.2
29_W-Freight 17-31	68.6	83.3	71.1	75.1	2.5	6.5
Slow train Os 2038	87.7	98.8	87.2	84.9	-0.5	-2.8
Freight train Vn 47772	87.0	103.2	83.2	81.9	-3.8	-5.1
Freight train Zn 44754	86.9	102.8	86.1	86.7	-0.8	-0.2

Continuation Table 12

Train	Leq dB(A)	SEL dB(A)	L(S03) dB(A)	L(SRM) dB(A)	d_S03 dB	d_SRM dB
Fast train Zr 1832	88.4	102.0	86.4	84.4	-2.0	-4.0
Express train Ec 131	84.1	96.6	80.7	75.5	-3.4	-8.6
Express train Ec 130	85.7	98.4	79.5	74.5	-6.2	-11.2
Slow train Os 2313	82.2	94.8	82.8	73.8	0.6	-8.4
Slow train Os 2040	81.3	95.1	81.6	78.2	0.3	-3.1
Freight train Nex 47610	84.6	99.2	83.2	83.5	-1.4	-1.1
Slow train Os 2009	87.6	101.5	86.6	84.4	-1.0	-3.2
Slow train MOs 2312	79.8	91.6	79.4	78.3	-0.4	-1.5
Fast train Zr 1831	89.3	103.4	87.7	85.7	-1.6	-3.6
Fast train R 276	89.3	101.4	81.3	76.1	-8.0	-13.2
Freight train 43313	88.8	104.6	84.3	85.5	-4.5	-3.3
Slow train Os 2006	85.7	98.4	84.7	81.9	-1.0	-3.8
Slow train Os 2011	85.2	97.4	88.3	86.1	3.1	0.9
Freight train Nex I 61760	85.2	99.2	83.0	84.1	-2.2	-1.1
Express train EC 171	83.8	95.9	83.4	77.9	-0.4	-5.9
Slow train Os 2013	88.8	102.0	86.3	83.6	-2.5	-5.2
Freight train Zn 44723	84.0	98.1	81.3	79.8	-2.7	-4.2
Slow train Os 2008	85.0	97.3	85.1	82.3	0.1	-2.7
Freight train Pn 47758	84.7	99.6	83.2	84.5	-1.5	-0.2
Slow train Os 2314	83.0	94.7	80.1	79.3	-2.9	-3.7
Freight train Pn 67804	85.4	100.4	82.0	83.2	-3.4	-2.2
Freight train Zn 44745	84.5	101.9	82.1	83.1	-2.4	-1.4
Slow train Os 2015	86.8	100.2	85.7	84.6	-1.1	-2.2
Slow train Os 2010	81.7	95.5	80.5	79.8	-1.2	-1.9
Freight train Nex 47610	81.2	96.6	82.3	82.3	1.1	1.1
Freight train Nex 41754	89.4	105.7	85.5	85.9	-3.9	-3.5
2xLocomotive Lv 67803	75.5	88.0	70.4	75.6	-5.1	0.1
Fast train R 230	88.3	100.5	87.7	86.4	-0.6	-1.9
Fast train R 233	87.6	100.9	87.5	85.7	-0.1	-1.9
2xLocomotive Lv I 75204	80.7	90.3	79.9	78.1	-0.8	-2.6
				All	S03	SRMII
				Mean deviation	0.1	-0.5
				Standarddev.	3.1	4.2

Each line in the table above needed the calculation using the correct train parameters according to Schall03 and to SRMII.
The results show that SRMII in some cases underestimates the level by more than 10 dB. Even Schall03 produces in these cases levels that are too small – but the deviation is not as large.

SRMII is the proposed Interim method – so we tried to find the reason for these large deviations.
At first it must be stated that the documentation of SRMII is fairly bad – there is no short and precise description of all algorithms relevant or needed to create a reliable computer program that is available in English language.

Even the relevant EU-reports [22] are not sufficient to reduce the risk of different interpretation by different programmers. They repeat the content of the original papers with other wording, but the real deficiencies are not eliminated. Even the simplest requirement for a standardized EU-method – a simple test case with step by step results to control the reliability of a used program – is not included.

The method SRMII tries to be accurate by introducing many dependencies between different parameters linked in a complicated way. This makes it nearly impossible to control the calculation by a quick “hand-calculation”.

It could not be excluded that there was a bug in the SRMII calculation of the used computer program. So we sent a little and very clear test problem to other colleagues and even to developers of competitive programs.

The result was very disappointing.

The variation in the reported results, the impossibility to detect the reason for the differences, the lack of test problems and the extremely expensive and complicated measurements to include new train types in the database leaded to the decision that it cannot be recommended to introduce this method in Slovakia.

All the deficiencies indicated are avoided with Schall03. It is the German legal method used for many years, it is transparent and easy to use and – the main advantage – there are a lot of test problems officially approved that can be used to calibrate and certify computer programs. It can be stated that all competitive 4 programs that are able to calculate according to Schall03 give the same result within an uncertainty interval of some 0.1 dB.

The results in Table 12 show that the more complex description in SRMII lead not to higher, but clearly to lower accuracy in this simple cases.

It may be that the different source heights and the use of frequency spectra in the simulation with SRMII influence the results behind diffracting barriers – but this is not proved and an investigation to clarify this influence for practical cases is not possible in the frame of this project. Anyway the standard Schall03 is under revision to enclose these two dependencies – so after publication of the revised Schall03 it can be decided to adopt the modifications.

To sum up:
As a result of our investigations we cannot recommend to use SRMII as calculation for railway noise. An acceptable alternative is the German Schall03 with all modifications included in the ongoing revision to be in line with the EU-requirements.

7.4 Industrial facilities

7.4.1 Principles of modelling

The interim calculation method of industrial noise is based on ISO 9613 part 2.
This method is used worldwide and there is no serious alternative – it is therefore not necessary to do validation measurements or to adjust corrections.

Experience shows that the evaluation of industrial noise by including all sources of a plant into the model of a city is by far to costly if the importance of this source type relative to traffic sources is taken into account.

An acceptable compromise is to simulate industrial and commercial areas with area sources. If it is obvious that parts of a factory or plant radiate quite different the whole area is split up in more parts with different emission.

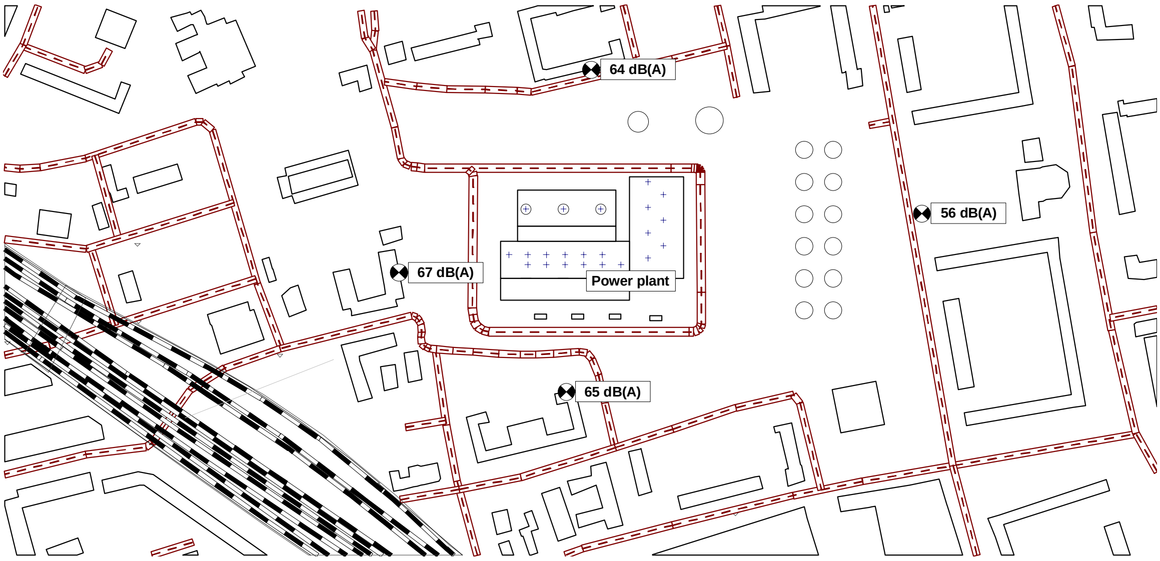

Figure 36: Power plant with residential buildings neighboured

Figure 37 shows a power plant with residential areas in the neighbourhood – the sound pressure levels produced by the plant are shown at 4 receiver points. Figure 37 is this model presented in a 3D-view.

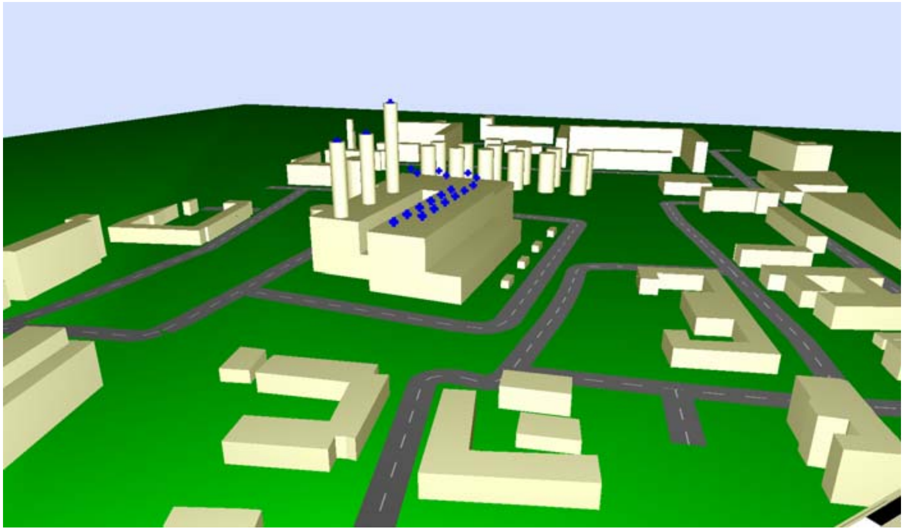

Figure 37: 3D-view of the detailed model with power plant

As it is mentioned above, it is by far to costly to create such detailed models in preparation of a city noise map.
In such cases it is the best procedure to replace the area of the plant by area sources as it is shown in Figure 38.

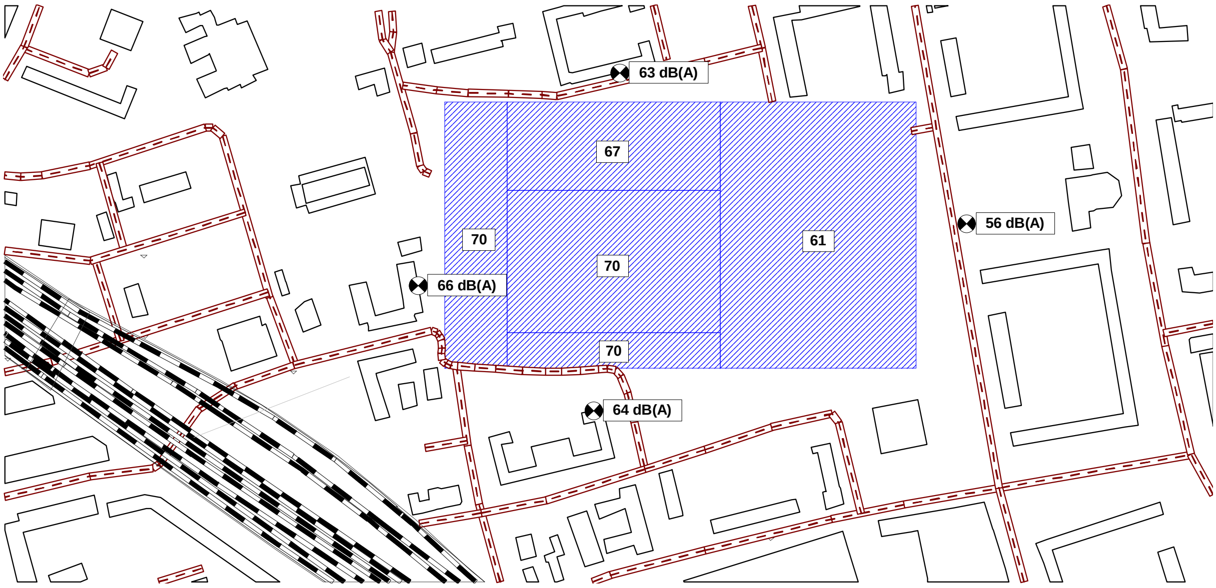

Figure 38: Replacement of the plant by 5 area sources (numbers L''WA in dB(A))

As it is shown, these area sources produce nearly the same sound pressure levels at the 4 receiver points.

7.4.2 Measurements

In the frame of this project no measurements have been undertaken to improve the validity of ISO 9613-2. This standard is used worldwide and there is no reason – and even no chance – to select another method.
For the practical application measurements can be helpful to find the emission of the simulating area sources. The measurements are taken outside the area – e.g. at the 4 points shown in Figure 37 and Figure 38. Then the emission of the replacing area sources are determined in a sort of back calculation – this procedure is implemented in most of the software programs used for calculating environmental noise.

7.5 Aircraft noise

7.5.1 Principles of modelling

The interim calculation method of aircraft noise is based on ECAC CEAC DOC.29.
This method should be used in all Europe and there is no serious alternative – it is therefore not necessary to do validation measurements or to adjust corrections.

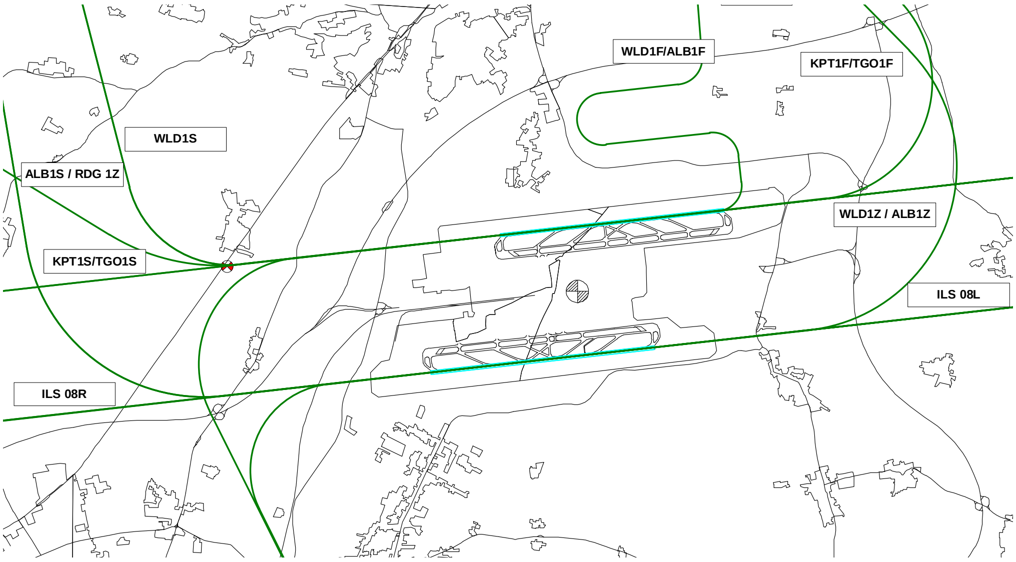

Figure 39 Runways and air-routes of Munich Airport

It should be noted that the aircraft groups for the ECAC method have been recently been published [22]. It is therefore necessary to examine if it is possible to describe the aircraft mix at Slovakian airports using this classification.

The following data must be acquired:
geometry of runways
geometry of flight paths (air-routes)
number of aircraft of each group for day, evening and night for each flight path

Air Route

Close | Sync. Graphic | Copy... | Print... | Font... | Help

Name	M.	ID	Airport	Type	Runway	Height	Descent Angle w (°)	Fade-In Range		Percentage (%)		Apps/Deps	
						h0 (m)	w (°)	Begin	End	Day	Night	Day	Night
WLD1S		FLG_S26L	München	Departure	26L	0.00				100.00	100.00	4.98	1.00
WLD1Z / ALB1Z		FLG_S26L	München	Departure	26L	0.00				100.00	100.00	292.00	8.00
ALB1S / RDG 1Z		FLG_S26L	München	Departure	26L	0.00				100.00	100.00	724.00	24.00
TULSI/CHIEM2S/SBG1S		FLG_S26L	München	Departure	26L	400.00				100.00	100.00	21476.00	629.00
KPT1S/TGO1S		FLG_S26L	München	Departure	26L	0.00				100.00	100.00	8156.00	208.00
WLD1N		FLG_S26R	München	Departure	26R	0.00				100.00	100.00	24.00	1.00
WLD1F/ALB1F		FLG_S26R	München	Departure	26R	0.00				100.00	100.00	9498.00	278.00
ALB1N/RDG1N		FLG_S26R	München	Departure	26R	400.00				100.00	100.00	24509.00	785.00
TULSI1/CHIEM1/SBG1N		FLG_S26R	München	Departure	26R	0.00				100.00	100.00	632.00	20.00
KPT1F/TGO1F		FLG_S26R	München	Departure	26R	0.00				100.00	100.00	2151.00	65.00
ILS 26R		FLG_L26R	München	Approach	26R	1076.00	3.00	30000.00	20000.00	100.00	100.00	33014.00	1727.00
ILS 26L		FLG_L26L	München	Approach	26L	1076.00	3.00	30000.00	20000.00	100.00	100.00	33013.00	1727.00

Figure 40: Example: Table of air-routes

7.5.2 Practical approach

It is recommended to acquire all the data for Bratislava airport based on one of the last years using the ECAC classification, to create a computer model, to calculate the levels and to compare them with measured levels if available.

Starting point is a listing of all aircraft types moving at Bratislava airport in one year. The next step is to attach one of the aircraft classes of AzB-99 (Annex 11.2) to each of these aircraft types. On the basis of the distribution of these aircraft groups on the flight paths the model can be created and the strategic noise maps are calculated using a certified computer program.

Dr. Wolfgang Probst /Team Leader/
ACCON GmbH
Greifenberg, 01.04.2005

8 Bibliography

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[3] Council Directive 77/311/EEC of 29 March 1977 on the approximation of the laws of the Member States relating to the driver-perceived noise level of wheeled agricultural or forestry tractors
[4] Council Directive 80/51/EEC of 20 December 1979 on the limitation of noise emissions from subsonic aircraft (80/51/EEC) , the council of the European communities
[5] Council Directive 92/61/EEC of 30 June 1992 relating to the type-approval of two or three-wheel motor vehicles
[6] Directive 2000/14/EC of the European Parliament and of the Council of 8 May 2000 on the approximation of the laws of the Member States relating to the noise emission in the environment by equipment for use outdoors
[7] Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise
[8] Law of the Government about Assessment and Control of Environmental Noise No. 2/2005, 1.2.2005 - Zákon o posudzovaní a kontrole hluku vo vonkajšom prostre
[9] Decree of the Government About Strategic Noise Maps and Action Plans for Noise Protection No. 43/2005, 15.2.2005 - Nariadenie vlády ,ktorým sa ustanovujú podrobnosti o strategických hlukových mapách a akčných plánoch ochrany pred hlukom
[10] Decree of the Ministry of Health about Provision of Data for Strategic Noise Maps (Draft) - Vyhláška ministerstva zdravotníctva Slovenskej republiky ktorou sa ustanovujú podrobnosti o údajoch poskytovaných k strategickým hlukovým mapám
[11] Guide of the National Public Health Institute about the methods to calculate strategic noise maps
[12] NMPB-Routes 96 (SETRA-CERTU-LCPS-CSTB), Methode de calcul incluant les effets meteorologiques, version experimentale, Bruit des intrastructures routieres, Janvier 1997 related to "Arreté du 5 mai 1995 relatif au bruit des infrastructures routiéres, Journal office du 10 mai 1995, article 6" and related to "XPS 31-133"
[13] Modification NMBP, Annex 1 in this Repot: Modifications of the calculation specification NMPB Routes 96 and the standard XP S 31-133 for application in the Slovakian Republic for calculation of the sound immissions of roads for strategic noise maps
[14] Schall 03: Calculation of sound immission of rail tracks - Richtlinie zur Berechnung der Schallimmissionen von Schienenwegen, Deutsche Bundesbahn 1990
[15] Modification of Schall 03, Annex 2 in this Report: Modifications of the calculation specification Schall 03 for application in the Slovakian Republic for calculation of the sound immissions of railways for strategic noise maps
[16] ISO 9613-2 Acoustics – Attenuation of sound during propagation outdoors – Part 2: General method of calculation, Ausgabe: 1999-10, Dämpfung des Schalls bei der Ausbreitung im Freien, Teil 2: Allgemeines Berechnungsverfahren
[17] Modification of ISO 9613-2, Annex 3 in this Report: Modifications of the calculation specification ISO 9613-2 for application in the Slovakian Republic for calculation of sound immissions from industry for strategic noise maps

[18] ECAC.CEAC Doc. 29 Report on Standard Method of Computing Noise Contours around Civil Airports, 1997
[19] Modification of ECAC.CEAC Doc. 29, Annex 4 in this Report: Modifications of the calculation specification ECAC.CEAC Doc.29 for application in the Slovakian Republic for Calculation of the sound immissions caused by air traffic at airports for strategic noise maps
[20] Reken- en Meetvoorschrift Railverkeerslawaai '96, Ministrie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20. November 1996
[21] Probst, W.: Project "The assessment and management of environmental noise" Inception Report, July 2004, Framework Contract AMS/451
[22] Adaption and Revision of the Interim Noise Computation Methods for the Purpose of Strategic Noise Mapping, Contract: B4-3040/2001/329750/MAR/C1

Annexes

Annex 1 : Additional Definitions For NMPB-Routes-96

A1-1 ANNEX 1 ADDITIONAL DEFINITIONS FOR NMPB-ROUTES-96

Modifications of the calculation specification NMPB Routes 96 and the standard XP S 31-133 for application in the Slovakian Republic for calculation of the sound immissions of roads for strategic noise maps

This guideline is to be used in the calculation of the noise of roads in addition to the original text of the guideline NMPB Routes 96 and the standard XP S 31-133 in legally regulated areas, in particular when applying the Law [8] regarding environmental noise. If individual specifications in this guideline deviate from specifications covering the same regulation in the original text of the NMPB ROUTES 96, the specifications in this guideline apply. Both guidelines together form the national Slovakian calculation method for noise caused by road traffic. Each adaptation to corresponding updates of the NMPB Routes 96 and the standard XP S 31-133 takes place by updating this guideline in conjunction with the edition stated.

A1-1.1 Emission values and noise indicators

According to the Law [8], the noise indicators L_{den} and L_{night} are to be used for description of the immission for the calculation of strategic noise maps. The takeoff point is the mean level in dB(A) related to the following periods:

Table A1. 1: Time blocks for determining noise indicators

Period	**Mean level**	**Time**
daytime	L_{day}	6 a.m. to 6 p.m.
evening	$L_{evening}$	8 p.m. to 10 p.m.
nighttime	L_{night}	10 p.m. to 6 a.m.

These mean levels are used to calculate the noise indicators in the manner described in the Law [8].
For this reason, the method of the guideline NMPB Routes 96 and the standard XP S 31-133 is to be used to calculate the sound pressure levels for the periods stated and from these the noise indicators.

The emission from roads is described by the A-evaluated, length-related sound power level (the sound power level per m in length) with a given octave band spectrum.

For data input, the mean hourly traffic volumes as motor vehicles / hour as well as the percentage proportion of heavy traffic are used.
As the immission values are to be the mean value in relation to the year, the same applies to the emission values and parameters from which they are calculated – the hourly traffic volumes vehicles / hour and heavy traffic proportions in % for the day, evening and night averaged for an entire year are to be used.

If the traffic volumes related to 24 hours as vehicles / 24 hours as well as the percentage heavy traffic proportion are used for data input, the values related to the three periods must be determined from these traffic volumes. This is only permitted if a typical division has been determined by means of a count for each road category. The distribution results from the mean of al 7 weekdays, whereby these must not include any special vacation days and public holidays.

A1-1.2 Road categories

For the assignment of typical distributions of motor vehicle movements daytime / evenings / nighttime, the following road categories are to be distinguished:

Table A1. 2: Road categories

Road category	**Explanation**
In the agglomeration area Bratislava	
A1, A2	Highways and expressways
B1, B2	Orbitals and radial roads
C1	Minor road only with regional public transport
Outside	
	Highways and expressways
	Class 1 and Class 2

A1-1.3 Road surfaces

According to guideline NMPB Routes 96 and standard XP S 31-133, different road surfaces are taken into account by spectral correction values in dB with regard to the noise. The corresponding list of road surfaces in guideline NMPB Routes 96 and standard XP S 31-133 is replaced by the following table. The correction values stated in this table apply to each frequency band in the same way.

Table A1. 3: Road surfaces and correction values

Road surface	**Description**	**Correction value in dB**
Poured asphalt	Smooth poured asphalt, mastic asphalts	0
Corrugated concrete	Corrugated cement concrete, with dilatation gap with poured asphalt, surface of level concrete slab, corrugated poured asphalt	+2
Steel-brushed concrete	Steel-brushed concrete surface	+1
Concrete texturized with jute cloth	Concrete surface with longitudinal texturing with jute cloth	-2
Level paving, smooth	Paving with level and smooth surface	+3
Uneven paving	Damaged paving, paving with corrugated surface, paving with gaps, cobblestones	+6
Asphalt-concrete, corrugated	Asphalt-concrete surface with medium structure, corrugated	+2
Asphalt-concrete, old	Asphalt-concrete surface with medium structure, old, surface smooth from long use	0
Asphalt-concrete, corrugated, damaged	Asphalt-concrete surface with medium structure, damaged and with gaps, partly repaired	+3
Asphalt blanket with mastic	Asphalt blanket with mastic, top surface with medium structure, modified asphalt with mastic, partially closed pores	-2
Asphalt blanket with	Asphalt blanket with open pores, top surface	-4

Road surface	Description	Correction value in dB
natural rubber and woven fabric	with fine to medium structure, modified asphalt with natural rubber and woven fabric (e.g. fiber glass)	

Correction values for surfaces not in this table can be determined according to the simplified method described in [22].

A1-1.4 Meteorology

The strategic noise maps as well as all other noise information are to be based on the annual long-term mean level.
According to guideline NMPB Routes 96 and standard XP S 31-133, the two meteorological divergence conditions "favorable" and "homogeneous" are taken into account. In principle, the percentage proportion of these two states is to be derived from local meteorological observations.
For application of this guideline to strategic noise mapping, a division independent of location is assumed. This results from the following table

Table A1. 4: Proportion of divergence condition "favorable"

Period	Proportion of "favorable"
daytime	50 %
evening	75 %
nighttime	100 %

A1-1.5 Shielding and reflection by building and other objects

Reflecting objects are taken into account by calculation of the possible – also shielded – reflections of the first order, whereby at least all reflection surface areas are to be included where the distance from the railway section and/or from the immission point under examination is less than or equal to 100 m. As a general principle, the reflection loss for reflecting objects is assumed to be 1 dB and/or the degree of absorption is assumed to be 0.2.

If there is closed construction on both sides of a road or a reflecting wall on each side or another reflecting object, the multiple reflection this causes is taken into account by an addition to the immission caused by that road section. This only applies if the proportion of gaps on both sides does not exceed 30% at least over a length that is 10 times the distance to the façade.

This multiple reflection addition is calculated using

$D_{ref} = 4h/w$
with
D_{ref} addition to the immission caused by the road section in dB
h mean height of the opposing reflecting façades or walls
w mean distance of the opposing reflecting façades or walls

Annex 2 : Additional Definitions For SCHALL 03

A2-1 ANNEX 2 ADDITIONAL DEFINITIONS FOR SCHALL 03

Modifications of the calculation specification Schall 03 for application in the Slovakian Republic for calculation of the sound immissions of railways for strategic noise maps

This guideline is to be used in the calculation of the noise of railways in addition to the original text of the guideline Schall 03 in legally regulated areas, in particular when applying the Law [8] regarding environmental noise. If individual specifications in this guideline deviate from specifications covering the same regulation in the original text of Schall 03, the specifications in this guideline apply. Both guidelines together form the national Slovakian calculation method for noise caused by railways. Each adaptation to corresponding updates of Schall 03 takes place by updating this guideline in conjunction with the edition of Schall 03 stated.

A2-1.1 Noise indicators

According to the calculation specification Schall 03, the sound immission caused by railways is described by the assessment level in dB(A).

If the guideline is applied for the purpose of calculating strategic noise maps, the Law [8] stipulates that the noise indicators L_{den} and L_{night} are to be used to describe the immission. The takeoff point is the mean level in dB(A) related to the following periods:

Table A2. 1: Time blocks for determining the noise indicators

Period	Mean level	Time
daytime	L_{day}	6 a.m. to 6 p.m.
evening	$L_{evening}$	18 p.m. to 10 p.m.
nighttime	L_{night}	22 p.m. to 6 a.m.

These mean levels are used to calculate the noise indicators in the manner described in the Law [8]. For this reason, the Schall 03 method is to be used to calculate the assessment levels for the periods stated and these are then used to calculate the noise indicators.

The emission of railways is described by the emission level $L_{m,E}$. This emission level $L_{m,E}$ in dB(A) is the mean level at 25 m distance, 3.5 m height above the upper edge of the rails from the axis of the track being examined, with free sound divergence. It serves as the starting variable for calculation of the assessment level.
On application of Schall 03 in line with the Law [8], the emission levels Lm,E are determined from the train movement figures of the 3 periods stated. The equation (1) of Schall 03 is therefore to be evaluated separately for the 3 periods.

A2-1.2 Types of train

The emission of railways is described according to Schall 03 by an emission base level of 51 dB(A) for a train of 100 m in length, 100% proportion of disc brakes and a speed of 100 Km/h. The reference values in Schall 03: Table 2 assigns typical values for disc brake proportion, length and speed to the types of train stated there.
This Table 2 will be replaced by the following Table A2. 2 with the stated parameters.

Table A2. 2: Reference values for speeds and lengths of various types of train

	Train category	**Maximal speed (km/h)**	**Average length of train (m)**	**Disc brakes %**
EC	EuroCity	160	200	100 %
IC	InterCity	160	200	100 %
Ex	Express trains	160	200	20 %
R	Fast trains	140	240	20 %
Zr	Local express trains	120	150	
Os	Slow trains	120	160	
EMOs	Electric-engine passanger trains	120	50	
Nex	Express freight trains	120	300	
Rn	Fast freight trains	140	330	
Zn	Local express freight trains	80	600	
Vn	Offset freight trains	80	450	
Pn	Through freight trains	70	450	
Mn	Way freight trains	50	200	
Pv	Exchange trains	50	200	
Lv	Locomotive train	70	30	
Vleč	Branch-line trains	50	100	

A2-1.3 Tracks with irregularities

In Table 5, Section 5.5 of Schall 03, the influence of the railway track type is taken into account with a correction value D_{Fb} in dB.
These values are to be increased by 2 dB if the track on average has at least one irregularity per 100 m. (This therefore does not apply to seamlessly welded tracks).

A2-1.4 Track bonus

The track bonus stipulated according to Schall 03 of 5 dB is not to be applied. This means that of the equation (6) is applied,
$S = 0$
is set.

A2-1.5 Meteorology

The strategic noise maps as well as all other noise information are to be based on the annual long-term mean level. This results by taking into account a meteorological correction C_{met}, which is to be additionally deducted in the calculation of the assessment level from the emission level according to equation (6) of Schall 03.

The meteorological correction C_{met} is calculated according to section 8 of the international guideline ISO 9613-2: 1999.

Here, the location factor C_0 is to be assumed according to
3 dB daytime, 1 dB evenings and 0 dB nighttime
as constant
or calculated according to

$$C_0 = -10 \cdot \log\left(\frac{T_1}{100} + \frac{0,7 \cdot T_2}{100} + \frac{0,1 \cdot T_3}{100}\right) dB$$

from the wind distribution applicable for the mean year

Here, the following applies

T_1 proportion of tailwind weather and calm (inversions) in the annual average in %

T_2 proportion of crosswind weather in the annual average in %

T_3 proportion of headwind weather in the annual average in %

T_1, T_2 and T_3 are determined from the frequency distribution of the wind directions, which is to be specified in 12 classes (compass point sectors each with 30 degrees) and with a class for no wind.

The three groups for wind direction are defined:

Tailwind: ±45° in divergence direction (= 90° sector) and calm

Crosswind: 45° to 135° and 225° to 315° to divergence direction

Headwind: ±45° against divergence direction

For the calculation, a C_0 dependent on its direction is to be determined for each sound beam and used as basis for calculation of the divergence attenuation.

A2-1.6 Screening and reflection by building and other objects

Reflecting objects are taken into account by calculation of the possible – also shielded – reflections of the first order, whereby at least all reflection surface areas are to be included where the distance from the railway section and/or from the immission point under examination is less than or equal to 100 m. As a general principle, the reflection loss for reflecting objects is assumed to be 1 dB and/or the degree of absorption is assumed to be 0.2.

Annex 3 : Additional Definitions For ISO 9613-2

A3-1 ANNEX 3 ADDITIONAL DEFINITIONS FOR ISO 9613-2

**Modifications of the calculation specification ISO 9613-2
for application in the Slovakian Republic
for calculation of sound immissions from industry
for strategic noise maps**

This guideline is to be used in the calculation of the noise of industry in addition to the original text of the international guideline ISO 9613-2 in legally regulated areas, in particular when applying the Law [8] regarding environmental noise. If individual specifications in this guideline deviate from specifications covering the same regulation in the original text of ISO 9613-2, the specifications in this guideline apply. Both guidelines together form the national Slovakian calculation method for noise caused by industry. Each adaptation to corresponding updates of ISO 9613-2 takes place by updating this guideline in conjunction with the edition of ISO 9613-2 stated.

A3-1.1 Noise indicators and emission values

The noise immission caused by industry is described by the assessment level in dB(A).

If the guideline is applied for the purpose of calculating strategic noise maps, the Law [8] stipulates that the noise indicators L_{den} and L_{night} are to be used to describe the immission. The takeoff point is the mean level in dB(A) related to the following periods:

Table A3.1 Time blocks for determining the noise indicators

Period	**Mean level**	**Time**
daytime	L_{day}	6 a.m. to 6 p.m.
evening	$L_{evening}$	18 p.m. to 10 p.m.
nighttime	L_{night}	22 p.m. to 6 a.m.

These mean levels are used to calculate the noise indicators in the manner described in the Law [8]. For this reason, the ISO 9613-2 method is to be used to calculate the assessment levels for the periods stated and these are then used to calculate the noise indicators.
This means that for the industrial operations to be assessed the emission values related to the periods daytime, evening and nighttime according to the above table must be determined as mean, possibly spectral sound power level, as length-related sound power level (in the case of line sources) or as surface-related sound power level (in the case of surface sources).

A3-1.2 Sound divergence

The calculation of the sound divergence takes place according to ISO 9613-2, as a rule spectrally or, if e.g. only the A-evaluated sound power levels are known as emission values, according to the simplified method in section 7.3.2. The latter is also to be applied if the modeling of entire industrial areas is as surface sources.

For the calculation of shielding in section 7.4, the following comment is included for equation (18):

In (18), with multiple diffraction, e is added to the greater of the two distances d_{ss} and d_{sr}.

(This modification has been proven practice among experts for some time now, remedying a deficiency in ISO 9613-2).

A3-1.3 Meteorology

The strategic noise maps as well as all other noise information are to be based on the annual long-term mean level. This results by taking into account a meteorological correction C_{met}, which is to be additionally deducted in the calculation of the assessment level from the emission level according to equation (6) of Schall 03.

The meteorological correction C_{met} is calculated according to section 8 of the international guideline ISO 9613-2: 1999.

Here, the location factor C_0 is to be assumed according to
3 dB daytime, 1 dB evenings and 0 dB nighttime
as constant

or calculated according to

$$C_0 = -10 \cdot \log\left(\frac{T_1}{100} + \frac{0{,}7 \cdot T_2}{100} + \frac{0{,}1 \cdot T_3}{100}\right) dB$$

from the wind distribution applicable for the mean year

Here, the following applies
T_1 proportion of tailwind weather and calm (inversions) in the annual average in %
T_2 proportion of crosswind weather in the annual average in %
T_3 proportion of headwind weather in the annual average in %

T_1, T_2 and T_3 are determined from the frequency distribution of the wind directions, which is to be specified in 12 classes (compass point sectors each with 30 degrees) and with a class for no wind.

The three groups for wind direction are defined:

Tailwind: ±45° in divergence direction (= 90° sector) and calm
Crosswind: 45° to 135° and 225° to 315° to divergence direction
Headwind: ±45° against divergence direction

For the calculation, a C_0 dependent on its direction is to be determined for each sound beam and used as basis for calculation of the divergence attenuation.

A3-1.4 Shielding and reflection by building and other objects

Reflecting objects are taken into account by calculation of the possible – also shielded – reflections of the first order, whereby at least all reflection surface areas are to be included where the distance from the source point and/or from the immission point under examination is less than or equal to 100 m. As a general principle, the reflection loss for reflecting objects is assumed to be 1 dB and/or the degree of absorption is assumed to be 0.2.

Annex 4 : Additional Definitions For ECAC.CEAC Doc 29

A4-1 ANNEX 4 – ADDITIONAL DEFINITIONS FOR ECAC.CEAC DOC 29

Modifications of the calculation specification ECAC.CEAC Doc.29 for application in the Slovakian Republic for Calculation of the sound immissions caused by air traffic at airports for strategic noise maps

This guideline is to be used in the calculation of the noise of air traffic in addition to the original text of the guideline ECAC.CEAC Doc. 29 in legally regulated areas, in particular when applying the Law [8] regarding environmental noise. If individual specifications in this guideline deviate from specifications covering the same regulation in the original text of the ECAC.CEAC Doc 29, the specifications in the current version of this guideline apply. Both guidelines together form the national Slovakian calculation method for noise caused by air traffic . Each adaptation to corresponding updates of ECAC.CEAC Doc.29 takes place by updating this guideline in conjunction with the edition stated.

A4-1.1 Noise indicators

NB: Still to be adapted to times in Slovakia

If the guideline is applied for the purpose of calculating strategic noise maps, the Law [8] stipulates that the noise indicators L_{den} and L_{night} are to be used to describe the immission. The takeoff point is the mean level in dB(A) related to the following periods:

Table A4. 1: Time blocks for determining the noise indicators

Period	Mean level	Time
daytime	L_{day}	6 a.m. to 6 p.m.
evening	$L_{evening}$	18 p.m. to 10 p.m.
nighttime	L_{night}	10 p.m. to 6 a.m.

These mean levels are used to calculate the noise indicators in the manner described in the Law [8].
The calculation of L_{den} and L_{night} can be performed according to chapter 9 (ECAC.CEAC Doc. 29), whereby the SEL values for each aircraft group j, for each segment m of each corridor path k of each flight path i with the flight movements for day, evening and nighttime are included in accordance

with $$L_{den} = 10 \cdot \lg\left(\frac{\tau_0}{T_{den}} \sum_{i,j,k,m} \left(N_{d,i,j,k} + 3{,}16 \cdot N_{e,i,j,k} + 10 \cdot N_{n,i,j,k}\right) \cdot 10^{SEL_{i,j,k,m}/10}\right)$$

and

$$L_{night} = 10 \cdot \lg\left(\frac{\tau_0}{T_n} \sum_{i,j,k,m} N_{n,i,j,k} \cdot 10^{SEL_{i,j,k,m}/10}\right)$$

whereby

T_{den} duration of Day + Evening + Night (24 hours = 86,400 s)
T_n duration of the night (8 hours = 28,800 s)

N_d, N_e, N_n are the number of flight movements during one day (12 h), one evening (4 h) and one night (8 h). The movement figures depend on the flight path, the aircraft group and the corridor path.

A4-1.2 Aircraft groups

The so-called AzB-99 aircraft groups are used as basis. These aircraft groups and their emission data also described in the report
"ADAPTATION AND REVISION OF THE INTERIM COMPUTATION METHODS FOR THE PURPOSE OF STRATEGIC NOISE MAPPING", WP 3.3.3: Aircraft noise around airports – noise emission: databases.

Table A4. 2: Aircraft groups according to AzB 99 for ECAC.CEAC Doc 29

Group	Definition of the groups
P1.1	Power gliders
P 1.2	Propeller aircraft with a maximum take-off mass (MTOM) up to 2 t or power gliders for glider-towing
P 1.3	Propeller aircraft with maximum take-off mass (MTOM) up to 2 t
P 1.4	Propeller aircraft with a maximum take-off mass (MTOM) between 2 and 5.7 t
P 2.1	Propeller aircraft with a maximum take-off mass (MTOM) over 5.7 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3 or Chapter 10
P 2.2	Propeller aircraft with a maximum take-off mass (MTOM) over 5.7 t that cannot be assigned to aircraft group P 2.1
S 1.0	Jet planes with a maximum take-off mass (MTOM) over 34 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2.
S 1.1	Jet planes with a maximum take-off mass (MTOM) between 34 t and 100 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2 (without aircraft models Boeing 737 and Boeing 727).
S 1.2	Aircraft of the aircraft model Boeing 737 that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2.
S 1.3	Aircraft of the aircraft model Boeing 727 that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2.
S 2	Jet planes with a maximum take-off mass (MTOM) up to 100 t that do not correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I.
S 3.1	Jet planes with two or three propulsion units and a maximum take-off mass (MTOM) over 100 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2 or Chapter 3 and are not included in aircraft group S 6.1 or S 6.2. a) Take-offs with aircraft of aircraft group S 3.1 where the current take-off mass is up to 85% of the maximum take-off mass (MTOM). b) Take-offs with aircraft of aircraft group S 3.1 where the current take-off mass is more than 85% of the maximum take-off mass (MTOM) a/b) Landing with aircraft of aircraft group S 3.1
	a)
	b)
S 3.2	Jet planes with four propulsion units and a maximum take-off mass (MTOM) over 100 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 2 or Chapter 3 and are not included in aircraft group S 6.2. a) Take-offs with aircraft of aircraft group S 3.2 where the current take-off mass is up to 85% of the maximum take-off mass (MTOM). b) Take-offs with aircraft of aircraft group S 3.2 where the current take-off mass is more than 85% of the maximum take-off mass (MTOM) a/b) Landing with aircraft of aircraft group S 3.2
	a)
	b)
S 4	Jet planes with a maximum take-off mass (MTOM) over 100 t that do not correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I.
	a)

Group	Definition of the groups
	b)
S 5.1	Jet planes with a maximum take-off mass (MTOM) up to 50 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3.
S 5.2	Jet planes with a maximum take-off mass (MTOM) between 50 t and 120 t and a propulsion unit by-pass ratio greater than 3 that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3.
S 5.3	Jet planes with a maximum take-off mass (MTOM) between 50 t and 120 t and a propulsion unit by-pass ratio up to 3 that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3.
S 6.1	Jet planes with two propulsion units and a maximum take-off mass (MTOM) over 120 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3.The aircraft must be in the current directory of low-noise jet planes with a maximum take-off mass over 120 t (Annex).
S 6.2	Jet planes with three or four propulsion units and a maximum take-off mass (MTOM) between 120 t and 300 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3 (without aircraft model Airbus A340). The aircraft must be in the current directory of low-noise jet planes with a maximum take-off mass over 120 t (Annex). a) Take-offs with aircraft of aircraft group S 6.2 where the current take-off mass is up to 70% of the maximum take-off mass (MTOM). b) Take-offs with aircraft of aircraft group S 6.2 where the current take-off mass is more than 70% of the maximum take-off mass (MTOM) a/b) Landings with aircraft of aircraft group S 6.2
	a)
	b)
S 6.3	Aircraft of the aircraft model Airbus A340
S 7	Jet planes with three or four propulsion units and a maximum take-off mass (MTOM) over 300 t that correspond to the requirements of Annex 16 of the International Civil Aviation Treaty, Volume I, Chapter 3. a) Take-offs with aircraft of aircraft group S 7 where the current take-off mass is up to 70% of the maximum take-off mass (MTOM). b) Take-offs with aircraft of aircraft group S 7 where the current take-off mass is more than 70% of the maximum take-off mass (MTOM). a/b) Landings with aircraft of aircraft group S 7
	a)
	b)
H 1	Helicopters with a maximum take-off mass (MTOM) up to 2.5 t
H 2	Helicopters with a maximum take-off mass (MTOM) over 2.5 t