# Differences in noise modelling in Slovenia

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**Summary**

In recent years, we had an opportunity to collaborate in some noise assessment procedures where noise assessments of different laboratories have been performed simultaneously. We identified some significant differences in noise assessment results between laboratories in Slovenia. We estimate that there is no clear consensus on methods for predictive noise methods for planned projects. We analyzed input data, methods and results of predictive noise methods for two planned industrial projects, both were done independently by two laboratories. We also analyzed the data, methods and results of two interlaboratory collaborative noise models for two existing noise sources (railway and motorway). In cases of predictive noise modelling the differences in noise assessment results between different laboratories have ranged up to 10 dBA, which considerably exceeds the acceptable uncertainty ranged between 3 to 6 dBA. Contrary to predictive noise modelling, the differences in noise modeling results for existing noise sources between different laboratories were below 5 dBA, which was acceptable uncertainty set up by interlaboratory noise modelling organizer.

The lessons learned from the study were:

1) Predictive noise calculation using formulae from International standard SIST ISO 9613-2: 1997 is not an appropriate method to predict noise emissions of planned projects, since due to complexity of procedure they are not used strictly.

2) The noise measurements are important tools to minimize noise assessment errors of planned projects and should be in cases of predictive noise modelling performed at least for validation of acoustic model.

3) National guidelines should be made on the appropriate data, methods, noise source digitalization, validation of acoustic model etc. in order to unify the predictive noise models and their results in scope of Environmental Impact Assessments for planned projects.

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## 1. Introduction

Noise modelling has since the adoption of Directive 2002/49/EC [1] been the prevailing tool for strategic noise mapping of all major agglomerations and all major roads and railways. It implies to existing noise sources, where the results of noise modelling and mapping could be controlled by noise measurements, thus increasing reliability of the results. The accreditations of laboratories are also made for noise modelling of existing noise sources, based on the range of international standards.

On the other hand although noise modelling is widely used to predict environmental noise levels of planned (presently non-existing projects), the predictive noise modelling had not yet been sufficiently covered by European legislation and international standards, neither in the field of methods, nor in the field of required confidence levels of noise modelling results.

Noise modelling of existing and planned noise sources has many common characteristics:

- same input data to perform acoustic model could be used,
- same calculation methods could be used,
- same software to calculate noise emissions in the environment could be used, etc.

However, there is a lack of clear guidelines for predictive noise modelling concerning the following issues:

- the method for evaluation of predictive noise modelling results,
- the way of obtaining and digitizing input data on planned noise sources.

The aim of this article is to analyze the reasons for excessive deviations of results of interlaboratory noise modelling of planned (non-existing) noise sources in scope of Environmental Impact Assessments and to propose possible solutions to unify the inputs data, methods, noise source digitalization, validation of acoustic models etc. with the purpose of increasing the reliability of predictive noise modelling results.

The subject of the analysis were noise assessments for cases – two planned projects and two existing projects. For all four cases at least two independent noise assessments were done, allowing comparing the differences in input data, noise assessment methods and results. We compared the deviations in calculated noise levels in cases of noise assessments of existing noise sources with those of planned projects. We analyzed possible reasons for excessive deviations of noise assessment results for planned projects. We proposed some possible solutions to obtain more comparable and thus more reliable results of predictive noise assessment procedures in scope of Environmental Impact Assessments (EIA).

## 2. Study cases

### 2.1. IED Plant A

A factory produces a wide range of metal products. The main activities are sheet metal forming, turning and milling of products, surface treatment of metal products, assembly of products and tool and die making.

The scope of noise modelling were planned extensions and improvements of the factory:

- Surface treatment installation in the southern part with the capacity of 72,8 $m^3$ of working baths for zinc, chromium and phosphate plating,
- Extension of the warehouse on the east northern part,
- An installation of the new biomass heating plant,
- Arranging rooms for washing, sandblasting and watering in an existing warehouse,
- Enlargement of parking area on the southern part of the industrial complex,
- Some smaller scale arrangements and resettings of existing installations.

### 2.2. IED Plant B

The factory produces resins and coatings for wide range of uses. It includes the production of coatings for wood, metal and plastic surfaces, decorative coatings, powder coatings and distillation of waste solvents.

The scope of noise modelling were planned extensions and improvements of the factory:

- replacement of one of resin synthesis lines with a new line along with:
    - the upgrade of the Vacuum Station (replacement of the water pump with dry one) in the Resins production facility and
    - the upgrade of the Cooling Station (replacement of two cooling towers with new ones)
- setting up a new pilot resin synthesis line.

### 2.3. Motorway section AC Vrhnika – Logatec

The motorway section AC Vrhnika – Logatec is an existing section of motorway A1 connecting the capital city Ljubljana with Slovenian coastal region. The motorway section runs east of Vrhnika city and has no driveways. Average daily traffic flow according to national traffic count in year 2015 is 41043.2 passages of light vehicles (less than 3.5 t) and 7196.4 passages of heavy vehicles (more than 3.5 t) in both directions, which means the motorway has approximately 17.5 million passages per year, thus classifies for major roads. Average speed of light vehicles is 130 km/h, average speed of heavy vehicles is 90 km/h. Along the whole motorway section there is a concrete barrier built with height of 2.2 m. The road upper layer is smooth mastic asphalt.

### 2.4. Railway section Zidani Most – Celje near village Tremerje

The existing electrified railway section Zidani Most – Celje near village Tremerje is a section of railway connecting the capital city Ljubljana with Slovenia's second largest city Maribor. The railway section is double-track, each having approximately 50 rail passages daily, according to national railway count in year 2015. The majority of passenger trains are passed in the day and evening time (90% in day and evening time), while freight trains are mostly passed in night hours (41 % in day time, 16 % in evening time and 43% in night time). Half of passenger trains are diesel block braked trains, in average with one motor unit and four pulled wagons. Half of passenger trains are electric disk braked trains, in average with one motor unit and three pulled wagons. All freight trains are block-braked trains, in average with one motor unit and 20 pulled wagons. Both tracks have ballast bed with wooden sleepers and standard jointless rails.

### 2.5. Time frame of study cases

Time frame of study cases and number of participating laboratories are as follows:

- Noise modelling for planned IED Plant A was done in 2014 by two laboratories,
- Noise assessment for planned IED Plant B was done in 2015 by two laboratories, with one laboratory using the calculation method according to International standard SIST ISO 9613-2:1997, while the other laboratory performed noise modelling procedure,
- Noise modelling for existing motorway section AC Vrhnika – Logatec was done in 2016 by 14 laboratories,
- Noise modelling for existing railway section Zidani Most – Celje near village Tremerje in 2016 was done by two laboratories.

## 3. Method and criteria of comparative analysis

The assessment of comparability of noise assessment results was done by comparing the predicted environmental noise emission levels of noise sources regarding the noise indicators $L_{day}$, $L_{evening}$, $L_{night}$ and $L_{den}$, which according to [1] are the A-weighted long-term average sound levels as defined in ISO 1996-2: 2007 determined over all periods of a year.

The criterion of comparatively of results was for every study case set differently and was in range from 1 to 5 dBA.

## 4. Comparison of the noise modelling methods and results

### 4.1. IED Plant A

Methods of noise modelling and input data for acoustic model were comparable between both laboratories, while the input data about planned noise source were slightly different. Both laboratories have gathered the noise emission data of existing parts of the plant by noise measurements, while the noise emission data about planned (non-existing) parts of the plant were gathered from technical specifications, similar cases or were based on investor information. The input data and noise modelling methods of both laboratories are seen from Table I [3, 4].

Table I. Comparison of input data and noise modelling methods of laboratory 1 and laboratory 2.

<table>
<tr><th></th><th>Laboratory 1</th><th>Laboratory 2</th></tr>
<tr><td>Input data – acoustic model</td><td colspan="2">Existing buildings – sound hard, reflection = 0.79, absorption = 0.21<br>Digitalisation of windows and doors of the plant building (consideration of heights and noise insulation: windows = 32 dBA, doors = 20 dBA)<br>Terrain with 1 m contours (irrelevant due to flat terrain)<br>Existing Traffic Density – aimed to calculate the background noise</td></tr>
<tr><td>Input data – noise source</td><td>Assembling (inside) – 85 dBA<br>Surface treatment and water treatment plant (inside) – 80 dBA<br>Biomass heating plant (inside) – 63 dBA<br>Forklifts (5x) (outside) – 70 dBA<br>Ventilation system (outside) – 56 dBA<br>Forklifts (inside) (2x) – 80 dBA<br>Air outlet from gas cleaning system (outside) – 75 dBA<br>Lorries – 0,17 drives/hour<br>Parking space - 6,5 drives/hour</td><td>Assembling (inside) – 80 dBA<br>Surface treatment (inside) – 74 dBA<br>Water treatment plant (inside) - 80 dBA<br>Biomass heating plant – /<br>Forklifts (5x) (outside) – 78 dBA<br>Ventilation system (outside) – 80 dBA<br>Forklifts (inside) (2x) – 78 dBA<br>Air outlet from gas cleaning system (outside) – 78 dBA<br>Heavy vehicles – 0,71 drives/hour<br>Parking space - 3 drives/hour</td></tr>
<tr><td>Validation of model</td><td>4 validation points:<br>Average difference between existing background noise measurements and modelling results: ±1,5 dBA</td><td>-</td></tr>
<tr><td>Noise modelling methods</td><td colspan="2">SIST ISO 9613-2 – industrial noise sources<br>NMPB in connection with XPS 31-133 for road noise sources</td></tr>
</table>

It is seen from Table I, that the biggest differences in noise modelling between both laboratories are in terms of input noise data describing existing and planned parts of the plant. We assume that the most relevant differences in input noise data are those describing the outdoor sources - forklifts, ventilation system, air outlet from gas cleaning system and traffic.

The results of noise modelling in time of the operation of the reconstructed IED Plant A (existing and new parts) of both laboratories are shown in Table II [3, 4].

Table II. Analysis of the results of noise modelling of laboratory 1 and laboratory 2

| Imission point | Lab. | $L_{day}$ | $L_{evening}$ | $L_{night}$ | $L_{den}$ |
|---|---|---|---|---|---|
| LIMIT VALUES | | 58 | 53 | 48 | 58 |
| SO1 – Ljubljanska cesta 92 | Lab. 1 | 53,1 | 46,7 | 43,4 | 53,0 |
| | Lab. 2 | 45,3 | 43,2 | 31,1 | 45,1 |
| DIFFERENCE | | -7,8 | -3,5 | -12,3 | -7,9 |
| SO2 - Ljubljanska cesta 82 | Lab. 1 | 50,0 | 43,0 | 43,5 | 51,0 |
| | Lab. 2 | 51,5 | 51,1 | 32,5 | 51,6 |
| DIFFERENCE | | +1,5 | +8,1 | -11,0 | +0,6 |
| SO3 - Ljubljanska cesta 86 | Lab. 1 | 50,7 | 44,8 | 41,8 | 50,9 |
| | Lab. 2 | 42,5 | 41,5 | 31,9 | 43,4 |
| DIFFERENCE | | -8,2 | -3,3 | -9,9 | -7,5 |
| SO4 - Vrhniška cesta 20 | Lab. 1 | 43,1 | 42,3 | 39,9 | 46,7 |
| | Lab. 2 | 41,7 | 40,8 | 28,8 | 42,1 |
| DIFFERENCE | | -1,4 | -1,5 | -11,1 | -4,6 |
| SO5 - Ljubljanska cesta 100 | Lab. 1 | 41,9 | 39,9 | 40,6 | 45,7 |
| | Lab. 2 | 44,2 | 43,1 | 32,4 | 44,8 |
| DIFFERENCE | | +2,3 | +3,2 | -8,2 | -0,9 |

The criterion to compare the modelling results of laboratories 1 and 2 was the uncertainty of laboratory 2 (that was higher than from laboratory 1), which was set to be ±4 dBAIt is seen from Table II, that the differences in modelled noise emission values between laboratories 1 and 2 in some indicators are higher than the allowed criterion of comparatively of results. It is also seen that the modelled noise emission values that the values of the noise of one laboratory by individual indicators and measuring points are not evenly higher or lower than those of the other laboratory.

No results in the nighttime are in the range of allowed deviation. The reason for that is, that the Laboratory 2 considered the departures of workers in the afternoon shift to be in the evening time (from 18 pm to 22 pm), which is not true, because the afternoon shift lasts until 22 pm.

It indicates that not only different noise input data regarding individual noise sources were used in noise modelling, but also different time durations of noise source operations and different noise source digitalization were considered by both laboratories. It indicates the lack of clear investor information or inadequate degree of precision of the plan of planned (non-existing) noise sources.

### 4.2. IED plant B

In case of planned reconstructions of IED Plant B the noise emission assessment in a period of plant operation was done by two different methods. Laboratory 1 has done the noise emission predictions by calculating the noise attenuation in the environment according to International standard SIST ISO 9613-2:1997, while Laboratory 2 performed noise modelling.

Input data to set up acoustic model, methods of noise calculations and modelling of Laboratory 1 and 2 are given in Table III [5, 6].

Table III. Comparison of input data and noise prediction methods

| | Laboratory 1 | Laboratory 2 |
|---|---|---|
| Input data – acoustic model | Existing buildings with noise insulation of 25 dBA<br>Flat terrain<br>Existing noise barriers around the plant area – noise insulation 25 dBA | Existing buildings - sound hard, reflection = 0.79, absorption = 0.21, noise insulation of walls – 48 dB<br>Digitalization of windows and doors of the plant buildings (consideration of heights and noise insulation: windows = 16 dBA, doors = 18 dBA)<br>Terrain with 1 m contours (irrelevant due to flat terrain)<br>Existing Traffic Density - – aimed to calculate the background noise<br>Existing noise barriers around the plant area (length 420 m, height 2,0 m) |
| Input data – noise source | Production (inside) – 78 dBA<br>Forklifts (outside) – 83 dBA/m<br>Additional cooling tower (outside) – 86 dBA<br>Heavy vehicles (outside) – 8 additional drives/day in daytime period<br>Light vehicles on the parking area (outside) – 35 drives/day in daytime period, 12 drives/day in evening time period, 24 drives/day in nighttime period | Production (inside) – 79,4 dBA<br>Forklifts (outside) – 80 dBA/m<br>Cooling towers – all 4 (outside) – 107,4 dBA<br>Heavy vehicles(outside) – 20 drives/day in daytime period<br>Light vehicles on the parking area (outside) - 219 drives/day in daytime period and 73 drives/day in evening time period |
| Validation of model | - | - |
| Noise modelling methods | SIST ISO 9613-1:1998 (calculation) | SIST ISO 9613-2 (modelling) – industrial noise sources<br>NMPB in connection with XPS 31-133 for road noise sources |

It is seen from Table III that the biggest differences in noise assessment between both laboratories are in terms of input noise data describing existing and planned parts of the plant, especially considering the cooling towers. Laboratory 2 considered all four cooling towers when assessing the predicted noise emissions of a plan, although the subject of plant reconstruction was only one cooling tower and 3 others are existing. Therefore the input noise level of laboratory 2 was 21,4 dBA higher than of laboratory 1.

The results of the modelling of noise emissions in time of the operation of the reconstructed plant IED Plant B of both laboratories are shown in Table IV [5, 6].

Table IV. Analysis of the results of noise calculation of laboratory 1 and noise modelling of laboratory 2

| Imission point | Lab. | $L_{day}$ | $L_{evening}$ | $L_{night}$ | $L_{den}$ |
|---|---|---|---|---|---|
| SO1 – Količevo 10D | Lab. 1 | 41,9 | 22,5 | 22,5 | 39,2 |
| | Lab. 2 | 53,6 | 43,1 | 43,1 | 52,9 |
| DIFFERENCE | | 11,7 | 20,6 | 20,6 | 13,7 |
| SO2 - Količevo 10F | Lab. 1 | 40,8 | 22,5 | 22,5 | 38,2 |
| | Lab. 2 | 53,2 | 44,2 | 44,3 | 53,2 |
| DIFFERENCE | | 12,4 | 21,7 | 21,8 | 15 |
| SO3 - Količevo 24 | Lab. 1 | 36,3 | 22,4 | 22,4 | 34,3 |
| | Lab. 2 | 54,6 | 45,9 | 45,9 | 54,7 |
| DIFFERENCE | | 18,3 | 23,5 | 23,5 | 20,4 |
| SO4 - Količevo 12 | Lab. 1 | 44,7 | 18,6 | 18,6 | 41,7 |
| | Lab. 2 | 34,5 | 26,4 | 26,6 | 35,0 |
| DIFFERENCE | | -10,2 | 7,8 | 8 | -6,7 |

The criterion to compare the modelling results of laboratories 1 and 2 was the uncertainty of laboratory 2, which was set to be ±4 dBA.

It is seen from Table IV, that the differences in calculated and modelled noise emission values between laboratories 1 and 2 are not comparable at all. One reason for that is in input noise data of cooling towers, described in a paragraph following the Table III. Additionally, the noise attenuation and noise reflections due to existing noise barrier are in noise calculation method considered simplified – just by reducing the noise emission values of the plant for noise insulation value of noise barrier.

We can conclude that the simplified calculation method using formulae from SIST ISO 9613-1:1998 is not usable in terms of predicting the noise emission values for planned projects in scope of IEA procedures, since it does not enable the consideration of all influential factors, affecting the assessed noise emission values, while ensuring transparency and acceptable time consumption at the same time.

### 4.3. Motorway section AC Vrhnika – Logatec

Input data to set up acoustic model for motorway noise modelling in scope of Interlaboratory Comparison (ILC) were the following publicly available GIS data:

- Existing buildings, sound hard, reflection = 0.79, absorption = 0.21;
- Terrain with 1 m contours;
- Land use with Motorway alignment.

Additionally the data about existing traffic density of the motorway were gathered from four nearby national traffic counting points.

Twelve laboratories out of fourteen performed accredited noise measurements of existing motorway traffic on the same noise assessment point. Noise measurements were done in different durations – most laboratories performed 24-hour noise measurements in the typical working day, some laboratories performed 1-hour noise measurements in all 3 periods of a day (day, evening and night). The criterion to compare the noise measurement results - the range of acceptable deviation of results was set to be ±4,5 dBA. All measurement results were in the range of allowed interval.

The noise measurement results were used as validation data for noise modelling performed with different software. The results of noise modelling of existing motorway traffic on the same noise assessment point are shown in Table V [7].

Table V. Results of noise modelling of motorway traffic in scope of ILC

| Laboratory | $L_{day}$ | $L_{evening}$ | $L_{night}$ | $L_{den}$ |
|---|---|---|---|---|
| Laboratory 1 | 51,0 | 45,0 | 42,0 | 51,0 |
| Laboratory 2 | 49,1 | 48,6 | 45,2 | 52,8 |
| Laboratory 3 | 47,1 | 46,1 | 42,7 | 50,3 |
| Laboratory 4 | 52,0 | 52,0 | 48,0 | 56,0 |
| Laboratory 5 | 51,9 | 50,6 | 48,0 | 55,4 |
| Laboratory 6 | 47,8 | 49,9 | 42,1 | 51,3 |
| Laboratory 7 | 47,4 | 45,3 | 40,6 | 49,2 |
| Laboratory 8 | 46,3 | 45,7 | 44,0 | 50,9 |
| Laboratory 9 | 45,1 | 44,3 | 40,8 | 48,5 |
| Laboratory 10 | 50,9 | 49,8 | 45,7 | 53,7 |
| Laboratory 11 | 48,3 | 46,8 | 42,9 | 50,9 |
| Laboratory 12 | 47,7 | 49,3 | 43,6 | 51,8 |
| Laboratory 13 | 52,7 | 49,0 | 46,3 | 54,4 |
| Laboratory 14 | 47,0 | 45,4 | 41,7 | 49,7 |
| **AVERAGE - MODELLING** | **48,9** | **47,7** | **43,8** | **51,8** |
| **AVERAGE - MEASUREMENT** | **49,3** | **46,8** | **42,9** | **51,4** |
| **DIFFERENCE** | **-0,4** | **0,9** | **0,9** | **0,4** |

It is seen from Table V that all measurement and modelling results of all laboratories were in the range of acceptable deviation. In addition, the measured and modelled noise emission values were in the range of 1 dBA, which means that the measurement results provided an excellent validation measures for noise modelling.

### 4.4. Railway section Zidani Most – Celje near village Tremerje

Input data to set up acoustic model for railway noise modelling in scope of Interlaboratory Comparison (ILC) were the following publicly available GIS data:

- Existing buildings sound hard, reflection = 0.79, absorption = 0.21;
- Terrain with 1 m contours;
- Land use with railway alignment.

Additionally the national data about existing average annual number of passenger and freight trains in all three daily periods were gathered for year 2015. The data about average number of motor units and pulled wagons were collected from national statistics.

Both laboratories performed accredited noise measurements of existing railway traffic on two noise assessment points in the daytime period in the duration of app. half an hour. The criterion to compare the noise measurement results - the range of acceptable deviation of results was set to be ±1 dBA. Measurement results were in the range of allowed interval.

The noise measurement results were used as validation data for noise modelling performed with the same software. Seven noise assessment points were chosen in front of the nearest residential buildings. The results of noise modelling of existing railway traffic are shown in Table VI [8, 9].

Table VI. Comparison of modeled railway noise emissions in the daytime of laboratory 1 and 2

| Assessment point | Modelled railway noise emissions in the daytime (dba) | | Difference of results (dba) |
|---|---|---|---|
| | Laboratory 1 | Laboratory 2 | |
| MO1 | 69,2 | 68,9 | -0,3 |
| MO2 | 57,9 | 57,3 | -0,6 |
| MO3 | 53,4 | 53,4 | 0 |
| MO4 | 51,5 | 51,8 | 0,3 |
| MO5 | 56,9 | 56,6 | -0,3 |
| MO6 | 57,6 | 57,2 | -0,4 |
| MO7 | 54,1 | 53,2 | -0,9 |

It is seen from Table VI, that the modelling results of both laboratories were in the range of acceptable deviation 1 dBA, which means that the measurement results provided an excellent validation measures for noise modelling.

## 5. Lessons learned from recent noise modelling practice

### 5.1. Subject to noise modelling

It should be clarified before proceeding with predictive noise modelling, what is the subject of EIA and therefore the subject to noise modelling. Sometimes the subject of an EIA is only a reconstruction of a part of plant. In such cases, the existing part of a plant should not be considered as a subject of EIA, but should in the second step be included in the evaluation of common noise emissions (overall environmental noise burden).

This topic is emphasized due to misunderstanding and inconsistencies when modelling and evaluating the noise emissions of planned projects in scope of EIA, seen in Slovenian noise modelling practice.

### 5.2. Appropriate method of noise assessment in scope of EIA

As was seen from the study case of IED Plant B, the noise calculation method according to International standard SIST ISO 9613-2:1997 is not an appropriate method to evaluate/predict noise emissions of planned (presently not existing plant). The reasons for such conclusion are:

- In most cases when calculating the predicted noise emissions, the simplified calculation method is used, not including the noise attenuation due to orientation of the noise source, ground effect or the effect of barriers.
- It does not include the effects of different types of facades, the heights of the buildings, the noise reflections, etc.
- Time consumption is high,
- Transparency is low (enormous set of formulae if strictly following the method described in SIST ISO 9613-2:1997),
- Consequently, the uncertainty of calculated noise emissions when using simplified method is too high.

We estimate that presently the most usable, transparent and verifiable method for predictive noise assessments is noise modelling. The methods for different noise sources, which are currently in practice and covered my national agenda in Slovenia, are:

- SIST ISO 9613-2 for industrial plants and facilities,
- NMPB – XPS 31 – 113 for road noise sources,
- RMR for railway noise sources.

Based on CNOSSOS-EU [10] and Commission Directive (EU) 2015/996 [2] new methods for noise assessment of different noise sources shall be implemented into national legislation by 31 December 2018 at the latest. These methods are prioritized for existing noise sources, especially for strategic noise mapping, which is especially reflected in the second paragraph of chapter 2.1.2. of Commission Directive (EU) 2015/996 [2]:*"In the application of the method, the input data shall reflect the actual usage. In general there shall be no reliance on default input values or assumptions. Default input values and assumptions are accepted if the collection of real data is associated with disproportionately high costs."*

It clearly means that the input data of noise sources shall be measured *In situ* and the operation durations shall be gathered from typical operation periods. However, this is only possible for existing noise sources. When assessing noise emissions of planned (presently non-existing) noise sources, the input noise data could only be gathered from technical data sheets or based on existing similar noise sources.

### 5.3. Input data about the planned noise source

When assessing the noise emissions of planned projects in scope of EIA, the following data should be gathered:

- The exact position of noise source,
- The height of noise source,
- The spatial layout of noise source (point, linear or areal noise source),
- Eventual direction of noise source,
- Sound power level or instantaneous sound pressure level of noise source,
- Period of predicted noise source operation.

The collection of all data requires collaboration of investor, design engineer and noise assessment expert. From Tables I and III of this article it is obvious that the input data about the planned noise sources were not harmonized for many possible reasons, such as different investor information, integration of existing noise sources in the noise assessment procedure, different reported types of planned noise sources followed by different technical data sheets with different noise data etc. Therefore the requirement of the first paragraph of chapter 2.1.2. of Commission Directive (EU) 2015/996 [2] could not be fulfilled: *"All input values affecting the emission level of a source shall be determined with at least the accuracy corresponding to an uncertainty of ± 2dB(A) in the emission level of the source (leaving all other parameters unchanged)."*

Based on these conclusions we propose to integrate a checklist about required input data about planned noise sources, either in a new national noise agenda, in the agenda regarding EIA procedures or in the national guidelines on noise assessment procedures in scope of EIA.

A checklist should follow the form similar to toolkits in [11], which presume different degrees of data accuracy based on best available data sources.

### 5.4. Input data to set up acoustic model

The possible source of errors in assessment of noise emissions of planned projects is also basic acoustic model itself. Acoustic model could lack of accuracy regarding some data, which could significantly affect the assessment results, such as building reflections, micro terrain elements, inclusion of windows and doors in acoustic model, some landscape elements, like bridges, existing noise barriers etc.

Therefore, the acoustic model has to be validated prior to its use for prediction of noise emission for planned projects. We suggest to validate an acoustic model on the basis of measured noise levels of existing surrounding noise sources, preferably roads, where the traffic density could be counted during measurements and the counting results could be duplicated in modeling existing noise emissions. The procedure is relatively simple and is not time- and cost consuming. The comparison of measured and modeled results gives reliable indication about suitability of acoustic model, which can in case of acceptable deviation between measured and modeled results be used to predict noise emissions for planned (non-existing) noise sources in scope of EIA.

## 6. Conclusion

Despite a Commission Directive (EU) 2015/996 [2] sets up strict new methods and requirements for input data for noise emission calculations for existing noise sources, especially for strategic noise maps, we identified a lack of requirements concerning the planned (non-existing) noise sources.

It lacks for example the clear guidelines for:

- Scope of noise modelling for planned projects (clear distinction between assessment of noise levels in time of operation of planned project and assessment of common noise emissions),
- Required data set to predict the noise emissions of planned (non-existing noise sources),
- The sources of required data,
- The required accuracy of input data (especially the data about planned noise sources),
- A need for validation of acoustic model to reach appropriate confidence level and repeatability of noise modelling,

Required reporting format for noise modelling in scope of EIA.

As a solution of given ambiguities we propose to set up national guidelines for noise emission assessment for planned projects, which would give uniform frame for data collection, required results and required reporting format of noise modelling in scope of EIA.

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