Round Table AAAA 2018

Roundtable "Noise legislation, its implementation in national laws, regulations and discovered challenges"

Moderator: Associate Professor Antonio Petošić

Organized by Croatian Acoustic Association

8th Alpe Adria Acoustics Association

21.09.2018, Zagreb

13:30-16:30

Agenda

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- **Participants: assessors and official persons** from Croatian Accreditation Agency (Ph. D. Ana Čop, dipl. ing. Ivan Stamenković), **from Ministry of Health** (dipl. ing. Valerija Golub, dipl. iur. Mario Vukoja and dipl. ing. Mislav Hajčić), prof. dr. sc. Jurij Prezelj and dipl. ing. Luka Čurović **assessors from Slovenian Accreditation Agency**, Alexander Niemczanowski from TGM Wien- **accredited laboratory in the field of acoustics measurements** (environmental noise, sound insulation (laboratory-in situ), dipl. ing. Peter Zatko - **A&Z Acoustics**, Slovak company for acoustic measurements and modelling of environmental noise parameters and sound insulation);
- Short introduction from TGM (Austria), University of Ljubljana, Faculty of Mechanical Engineering, and A&Z Company (Slovakia) and their expierence in the field;
- **Accreditation procedure generally** (purpose, methods, procedures...) and accreditation procedure according to old and new ISO 17025:2017 (by Croatian Accreditation Agency) ;
- **New ISO 1996:2:2017 and ISO 1996-1:2016 implementation in Slovenia, Austria, Slovakia, Croatia**, limit values for environmental noise and levels at workplaces, and sound insulation parameters;
- **New guidelines for reporting and rating measured/calculated values in the field of acoustics**;
- Conclusions (future ILC in this field);

Accreditation scheme for acoustic labs and problems in implementation- generally

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- ⇒ Companies in the field of acoustics which measure environmental noise parameters and sound insulation parameters **should have accreditation** according to the HRN EN ISO 17025:2005 (national legislation);
- ⇒ **The accreditation sign is obligatory for some purposes** (minimum technical conditions for some activities, checking agreement with project specifications, measurements according national legislative, measurements according the decree of sanitary inspector **or court**);
- ⇒ **Some customers demand services of accredited laboratories** (ISO 17025:2005 (2017) **because of trust**;
- ⇒ Implementation in labs in two years (till 20.11.2020 in Croatia).
- ⇒ **Problems with national regulations and laws regarding the noise** (noise from animals, day evening night definitions, religious objects are not included in law, **zones of noise are not in urbanistic plans, criterium of assesement (+1 dBA) with much larger measurement uncertainty;**

Accreditation or not for laboratories for measurements and calculations (?) of noise parameters (environmental, sound insulation, workplace)

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- Risk based thinking: reduction in prescriptive requirements and their replacement by performance based requirements;
- Greater flexibility regarding processes, procedures, documented information and organizational responsibilities;
- Definition of laboratory (testing, calibration, sampling)

ISO 17025:2017 standard used to accredit the competence of measurement laboratories in the field of acoustic measurements

System with ability to get technically valid measurement results and make valid report

Risk and opportunities;
- Difference in measurement procedures
- Uncertainties between labs;
- Risk of false accept;
- Decision rule used (with or without measurement uncertaitny);

- Impartiality:equal treatment of each party in measurement process;
- Scoping of laboratory activities included In lab system;
- Complaint handling (2nd person);

People who are doing measurements

Knowledge for following new standards

Equipment (sound level meter...) for doing measurements or software for calculations

Supplies (external calibration of instruments)

Measurement procedures (chosing appropriate measurement methods)

Acoustic measurement or calculation procedures- general approach for environmental noise

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Measure or estimate background noise parameters without considered source of interest according to ISO 1996-2:2017

Possible source of background noise: traffic, industrial plants, neighbourhood, animals, church bells...

Sources of measurement uncertainties: meteorological conditions (different meterological conditions, operating windows (number of vehicles), measurement chain..
different measurement positions,..

Estimate the new level of noise with new source plant installed at desired location by using some calculation methods according ISO 9613-2:1996

For road, railway and airplane traffic there are different methods of calculation

Input parameters: **sound power of each source in the industrial plant**, according ISO 3744:2010, number of vechicles, terrein, atmospheric attenuation, diffraction due obstacles (barriers, buildings)

Sources of uncertainties: measurement procedure for sound power or sound emission levels, reference conditions for traffic (ISO 1996-2:2017), positions of sources and receivers

Check the estimation with additional measurement after installation of new source according ISO 1996-2:2017

Assesment of measured or calculated values (sound descriptors) including corrections due to measurement position, type of noise (tonal, impulse), operating time (day, evening, night, weekend) according ISO 1996-1:2016

Sources of measurement uncertainties: meteorological conditions in different windows, operating conditions in different windows, measurement chain

Limit values are given by national legislative (A-weighted equivalent continuous sound pressure levels or sound descriptors)

Crucial questions-environmental noise and sound insulation

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- ⇒ **Is the measurement uncertainty overestimated and should we consider expanded uncertainty when we are doing assessment (influence of rounding and suggestions in ISO 12999-1:2014)?**
- ⇒ If it is not included in assessment should it be expressed in the report (+1 dBA, +3 dBA increase of level compared with hearing sensitivity +1 dBA....)
- ⇒ **How to measure meteorological conditions during environmental noise parameters measurements (resolution in time, wait to stabilize, which parameters to measure, at which height and position, for long term and short term measurements)?**
- ⇒ Should we use the results of interlaboratory comparisons or use GUM when expanded measurement uncertainty is calculated and reported (Austria)?
- ⇒ Should we calculate sound descriptors calculation from measured and rated noise levels (A-weighted equivalent sound pressure levels and time of working during day, evening, night period?
- ⇒ **Should we separate the reports (one with accreditation symbol) with all measured results (per positions, and in time, meteorology, equipment) and one for Ministry (only assessment of measured results without accreditation symbol)?**
- ⇒ **Where the measurement position should be put ?(0,5 m in front of openings, free field, near facade, at the facade, correction for comparison between predicted and measurement results)**

Influence of meteorological conditions-why to consider at longer and at shorter distances

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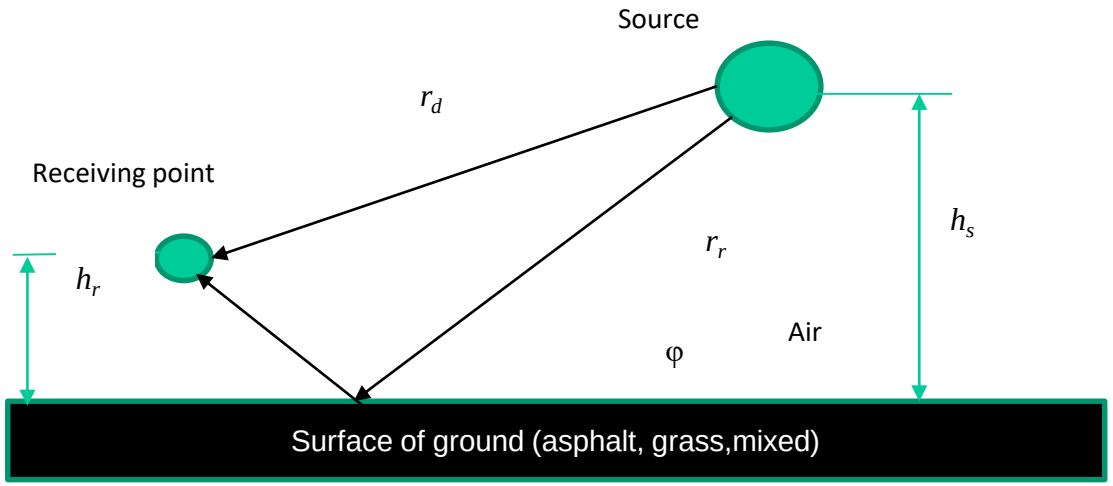
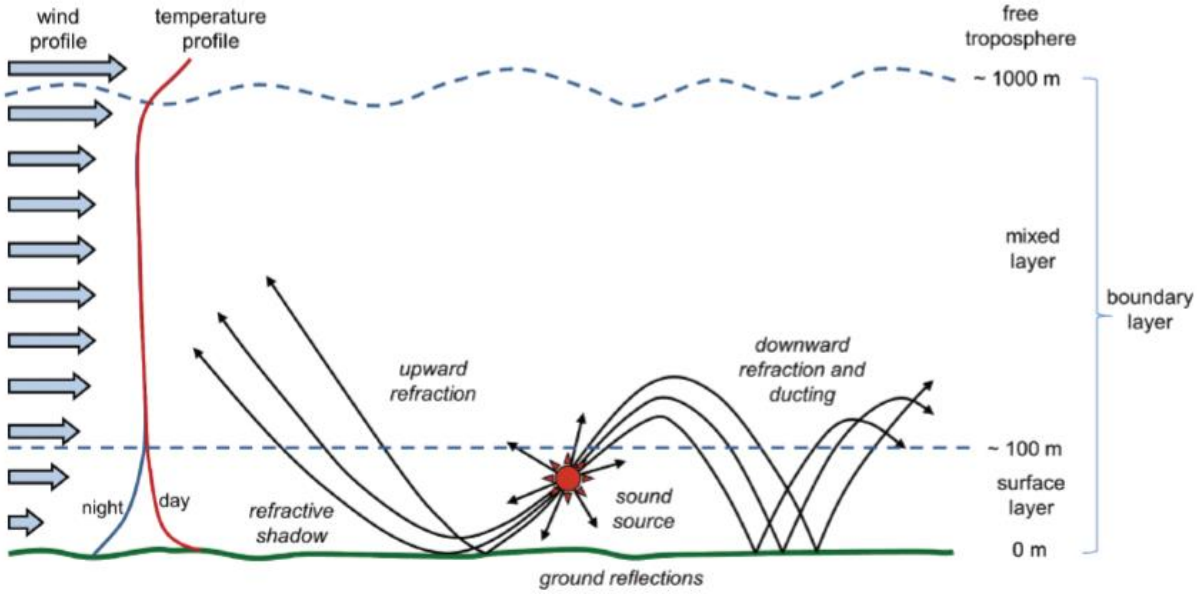
- Influence of ground surface type on ground reflection and influence of meterological conditions and influence of barriers ,atmospheric conditions between source and receiver;





Wilson et. al. ©2015 Acoustical Society of America

-recognise meterological window depending on the radius of curvature and distinguish favourable and unfavourable meterological conditions for sound propagation;

André Filipe Garcia Peixoto de Oliveira:The effect of wind and turbulence on sound propagation in the atmosphere Maio 2012;

Different operational and meteorological conditions

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⇒ Example of noise levels from large industrial site measured 5 different days at different operating and meteorological conditions (1 km from the source), figure [1];

⇒ A-weighted continuous equivalent sound pressure levels (15 min) measured from road at distance 80 m in different time periods (day, night), figure right

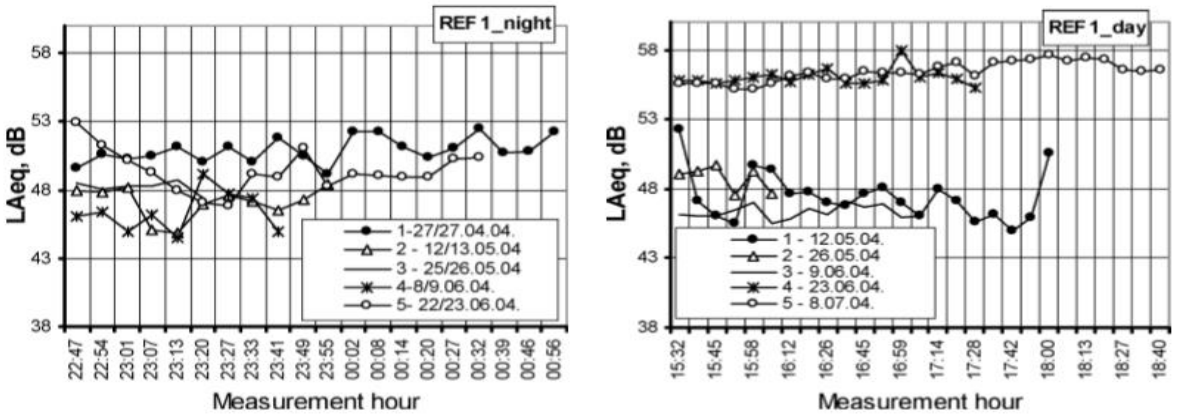
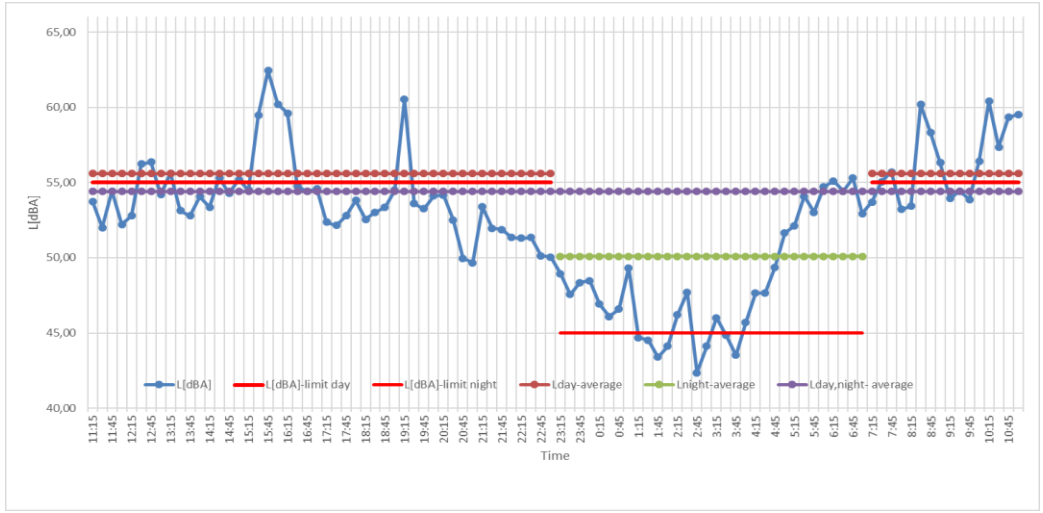


Fig. 1. Variation of noise equivalent levels in reference point REF1 in night-time and daytime, taken from 5 measurement sessions.



-**Meteorological conditions are usually monitored 15 min before starting the measurements and checked every 5 min until the end of the measurements (favourable meteorological conditions were verified)**

[1]Tadeusz WSZOŁEK:UNCERTAINTY OF INDUSTRIAL NOISE MEASUREMENT AT DISTANT LOCATIONS FROM THE SOURCE, ARCHIVES OF ACOUSTICS 32, 4 (Supplement), 279–290 (2007).

Austria (in cooperation with TGM)

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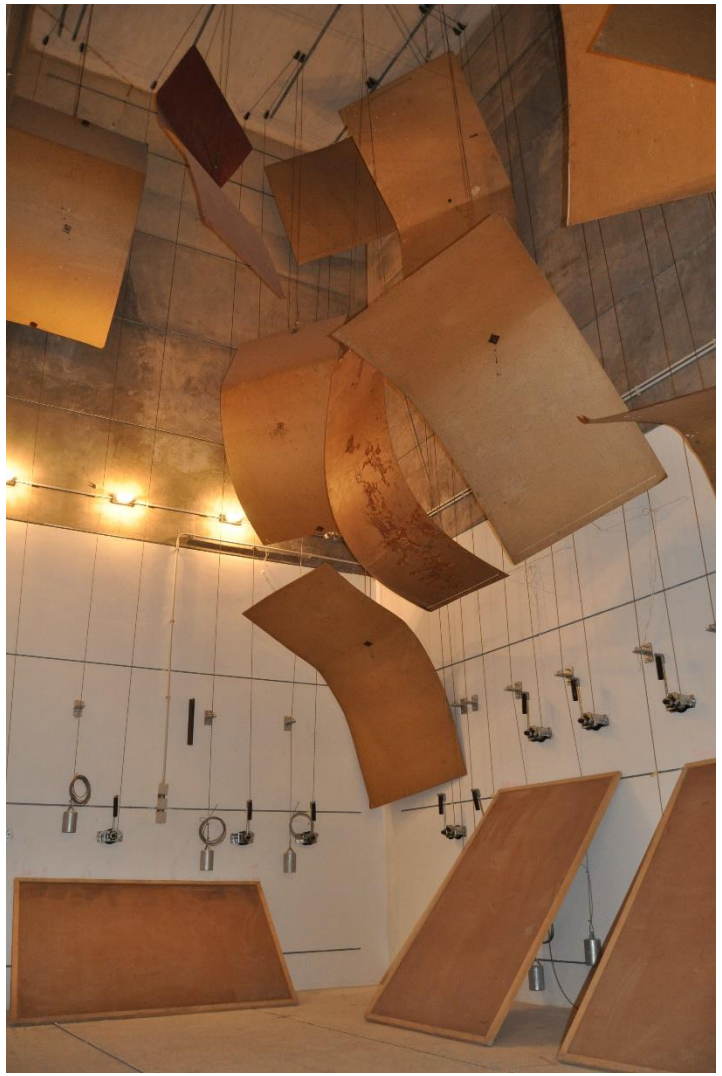
- ⇒ Ing. Alexander Niemczanowski (environmental noise measurements)
- ⇒ Ing. Mag. rer. nat. Herbert Muellner (laboratory and in-situ sound insulation measurements);
- ⇒ TGM company (Versuchsanstalt TGM, Fachbereich Akustik und Bauphysik, Wexstrasse 19-23, 1200 Wien, Austria);
- ⇒ **Facilities:** anechoic room, reverberation room and laboratory rooms for sound insulation measurement facilities, computer software for calculation of sound pollution and room acoustics;
- ⇒ **Some important acoustic projects:** Room acoustics of a cathedral, research about building acoustics in timber constructions, prognostic calculation of aircraft noise;

Laboratory rooms in TGM



Accreditation experience from Austria- general requirements

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⇒ Accreditation can be demanded only for measurement methods (environmental noise parameters, in-situ and laboratory sound insulation and many other acoustic parameters (flow resistivity, dynamic stiffness, absorption coefficients of materials, sound insulation and absorption of barriers...)

⇒ Accreditation according ISO 17025:2005 (2017) is mainly required by industrial clients who want to sell their tested products (sound insulation) in the EU;

⇒

Accreditation experience in the field of acoustics Austria-environmental noise

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- ⇒ Austrian laboratories are accredited for measurement of environmental noise according ISO 17025:2007 and new standard ISO 17025:2017;
- ⇒ The deadline for implementation of new standard is before 2021.
- ⇒ In the field of measuring environmental noise parameters there are Austrian standards (for measurements ÖNORM S 5004, Ausgabe 2008-12-01, and for assessment ÖAL-Richtlinie 3 Blatt 1);
- ⇒ The labs have to be accredited for measurements according ONORM S5004 having different purpose (minimal technical conditions, licence for working, checking technical projects.....
- ⇒ For an expert opinion about e.g. noise from a factory accreditation is not required, if the lawyer trusts in the institute.
- ⇒ Measurement and calculation methods for environmental noise parameters prediction;
- ⇒ Some aspects of ISO 1996-2:2008 were taken into account in ÖNORM S 5004 but it is more like instructions for measurements;
- ⇒ It is connected with Austrian version of standards ÖNORM EN ISO 354, ÖVE/ÖNORM EN 60942, ÖVE/ÖNORM EN 61260, ÖVE/ÖNORM EN 61672;

Short description of S 5004:2008

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- ⇒ Definition of basic parameters: (L_p, L_{eq}, L_E, $L_{A,95}$, $L_{A,1}$, T);
- ⇒ External calibration (every two years for sound level meter, and one year for calibrator);
- ⇒ Choosing the measurement positions (free field, in front of the reflection surface or on the facade, 0,5 m in front of the open window, **it is written explicitly if it is not possible then choose other position on the reflection surface**)
- ⇒ The height of microphone is from 1,5 m up to 2 m and for mapping purpose and estimation of future situations (noise mapping) is 4 m.
- ⇒ **Measured parameters $L_{A,eq}$, $L_{A,95}$, $L_{A,1}$, $L_{A,Sp}$ (fast A-weighted level) with sound descriptors calculation (L_{day}, $L_{evening}$, $L_{night,}$)**
- ⇒ Meteorological conditions are at least described qualitative (perception), special attention that measurements can't be done during snow condition because of high ground absorption;
- ⇒ Measurement uncertainty is fixed, determined from Interlaboratory comparisons, k=2 , 95% confidence interval and it is for $L_{A,eq}$ (traffic noise ±1,1 dBA, and for different types of noise sources ±2,1 dBA);
- ⇒ Special attention is given to the different type of noise events (continuous noise, impulse noise, intermittent noise....)

Crucial questions-Austria

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- ⇒ How to ensure the maximum working conditions of noise sources (the owner is responsible or some additional checking)?
- ⇒ What if some plant is working with closed window and doors openings?
- ⇒ Influence of measurement uncertainty, is it taken into account when assessment is done?
- ⇒ Interlaboratory comparisons (how often are ILC organized in different fields) and obtained standard deviation in reproducibility conditions is taken into account when sound descriptors are assesed?
- ⇒ Interlaboratory comparison results are taken into account when measurement uncertainty is determined in the field of environmental noise measurements

Sound insulation measurements in Austria

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- ⇒ Measurements according ÖNORM EN ISO 16283-1:2014; ÖNORM EN ISO 16283-2:2016, ÖNORM EN ISO 16283-3:2016 in situ and ÖNORM EN ISO 10140-1, -2, -3, -4, -5 in the laboratory
- ⇒ Verification of own measurement procedure (repeating five independent measurements with same instrumentation and people) has to be done?
- ⇒ Is the measurement uncertainty taken into account when assesment of measurement value is done (as suggested in ISO 12999-1:2014)?

Noise at workplace

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- ⇒ Austrian law with limiting values, that refers to ISO 1999:2018 Acoustics :Estimation of noise-induced hearing loss;
- ⇒ This law requires that measurements have to be done by a competent person, (what ever that means).
- ⇒ Accreditation according ISO 17025:2005 (2017) in its official meaning is not required.
- ⇒ In practice this depends on the individual officer, what (s)he requests.
- ⇒ Nevertheless the law that requires the official re-calibration of every sound level meter, which is used for any judgement, every two years.
- ⇒ Limit values: A-weighted noise exposure level normalized to an 8 h working day daily noise exposure level $L_{A,EX,8h}$, $L_{C,peak}$
- ⇒ Measurement Procedure according ISO 9612:2009.

Noise mapping in Austria

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⇒ Noise maps are calculated with RVS 04.02.11 (Road traffic), ONRegel 305011 (Railway), ÖAL-Richtlinie 24-1 (flight traffic) and ISO 9613-2 (industry).

⇒ CNOSSOS-EU should come in 2022.

⇒ noise experts of the town or country governments make the noise maps themselves.

⇒ Questions?

Slovenia

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- Prof. dr. sc. Jurij Prezelj and dipl. ing Luka Čurović
- Faculty of Mechanical Engineering, Slovenian Accreditation Agency;
- **Activities**: teaching, projects: industry, research;
- Facilities: anechoic room (V=9 m^3), alpha cabin (V=6.4 m^3), centrifugal pump test rig, reciprocating pump test rig, axial fan test rig,..
- **Equipment**: **acoustic camera**, **microphone arrays**, measurement microphones (all classes), sound intensity probe, laser doppler vibrometer, piezoelectric accelerometers, tapping machine, omnidirectional and directional sound sources, environmental noise propagation modelling software, fluid dynamics modelling software, room and duct acoustics modelling software, sound cards, open source and commercial programming software, 3d printer,…
- **Acoustic projects:** SA audits, Judicial expertise in acoustics, noise source identification, ranking and noise reduction of home appliance (Gorenje), design of suction units (Domel), identification of noise sources in Port of Koper, acoustical testing of sound reduction devices used for reduction of traffic noise, design of compressors and compressed air delivery systems (Omega Air), noise source identification using acoustical camera, design of vibro acoustical systems used in QA/QC on production line (Akrapovič, Iskra sistemi), design of advanced environmental noise measurement systems using directivity and neural networks (SANSIC), study of loudspeaker as electromechanical systems

Accreditation procedure in Slovenia-field of acoustics

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- ⇒ **Purpose of accreditation**: accreditation according to SIST EN ISO/IEC 17025 (SIST EN ISO 17020) is necessary to receive authorization from the Environmental Agency (MOK, ARSO) to perform environmental noise monitoring (measurement / calculation):
  - ⇒ SIST ISO 1996-2 in connection with ISO 1996-1, 9613-2, XPS, RMR, ISO 10843, ISO/TS 13474, ECAC
- ⇒ **accreditation according to SIST EN ISO/IEC 17025 is necessary when one wants to perform measurements in the field of building acoustics:**
  - ⇒ SIST EN ISO 140-4, 140-5, 140-7 (notice that almost all standards have been withdrawn and replaced with 16283),
  - ⇒ SIST EN ISO 717-1, SIST EN ISO 3382-1, SIST EN ISO 3382-2, TSG-1-005:2012
- ⇒ **accreditation according to SIST EN ISO/IEC 17025 is necessary when it is required by clients:**
  - ⇒ ISO 9612, SIST TS CEN/*TS 1793, SIST ISO 10847, SIST EN ISO 3095*
- ⇒ **Number of laboratories in the field of acoustics**:

19 - environmental noise, 8-sound insulation, >150 noise at workplace

Slovenia - regulation

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- **Number of regulations for acoustics**:
  - Directive 2002/49/EC relating to the assessment and management of Environmental noise,
  - Commission Recommendation 2003/613/EC concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data;
  - Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure - Version 2;
  - Directive 2000/14/EC relating to the noise emission in the environment by equipment for use outdoors;
  - Uredba o ocenjevanju in urejanju hrupa v okolju (Uradni list RS, št. 121/04);
  - Uredba o mejnih vrednostih kazalcev hrupa v okolju (Uradni list RS, št. 43/18),
  - Uredba o načinu uporabe zvočnih naprav, ki na shodih in prireditvah povzročajo hrup (Uradni list RS, št. 1118/05),
  - Pravilnik o emisiji hrupa strojev, ki se uporabljajo na prostem (Uradni list RS, št. 106/02, 50/05 in 49/06, 49/06),
  - Pravilnik o prvem ocenjevanju in obratovalnem monitoringu za vire hrupa ter o pogojih za njegovo izvajanje (Uradni list RS, št. 105/08),
  - Pravilnik o zaščiti pred hrupom v stavbah (Uradni list RS, št. 10/12 in 61/17 – GZ)
  - Tehnična smernica TSG-1-005:2012-Zaščita pred hrupom v stabah ;
  - Pravilnik o varovanju delavcev pred tveganji zaradi izpostavljenosti hrupu pri delu (Uradni list RS, št. 17/06, 18/06 – popr. in 43/11 – ZVZD-1)
- **Responsible ministry and interested parties**:
  - Ministry of the Environment and Spatial planning (MOP),
  - Environmental Agency (ARSO),
  - Ministry of Labour, Family, Social Affairs and Equal opportunities,
  - Administrative units,
  - Municipalities,
  - Civil initiatives,
  - Environment protection movements,
  - Citizens.

Detailed scope of accreditation -example for some methods

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Tip obsega: **fiksni** / *Type of scope:* ***fixed***
Mesto izvajanja: **na terenu** / *Site:* ***fieldwork***
Področja preskušanja glede na vrsto preskušanja: **akustika, hrup, vibracije (hrup)** / *Testing fields with reference to the type of test:* ***acoustics, noise, vibrations (noise)***
Področja preskušanja glede na vrsto preskušanca: **okolje in vzorci iz okolja (okolje) /** *Testing fields with reference to the type of test item:* ***environment and samples from environment (environment)***

Oznaka standarda ali nestandardne preskusne metode ***Reference*** *to standard or non-standard testing method*	**Naslov standarda** ali nestandardne preskusne metode in morebitne navezave na druge standarde ali metode ***Title of standard*** *or non-standard testing method and eventual relations to other standards or methods*	**Območje** preskušanja; **Negotovost** rezultata preskušanja (kjer je to pomembno) ***Range*** *of testing;* ***Uncertainty*** *of the result of testing (where relevant)*	**Materiali; proizvodi** ***Materials; products***
SIST ISO **1996-2:2017**	Akustika – Akustika - Opis, merjenje in ocena hrupa v okolju - 2. del: Določanje ravni zvočnega tlaka *Acoustics - Description, measurement and assessment of environmental noise - Part 2: Determination of sound pressure levels* V navezavi s SIST ISO **1996-1:2016**	**območje merjenja:** **(24 – 130) dBA** **frekvenca območja:** **(20 – 20000) Hz** *range of measurment:* *(24 – 130) dBA* *frequency range:* *(20 – 20000) Hz*	naravno in življenjsko okolje *natural and living environment*
SIST EN ISO 3744:2010	Akustika - Ugotavljanje ravni zvočnih moči virov hrupa z merjenjem zvočnega tlaka - Inženirska metoda v pretežno prostem polju nad odbojno ravnino (ISO 3744:2010) *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane (ISO 3744:2010)*	**območje merjenja:** **(24 – 130) dBA** **frekvenca območja:** **(20 – 20000) Hz** *range of measurment:* *(24 – 130) dBA* *frequency range:* *(20 – 20000) Hz*	stroji in naprave *machinery and devices*

Implementation of new standard SIST ISO 1996-2:2017 in Slovenia

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- **SIST accepted ISO 1996-2:2017 on 1.9.2017, ISO 1996-2:2007 was withdrawn**
- MOP implementation of new standard starts immediately and measurements shall be performed according to the new version. **No adaptation period. (FDIS)**
- **parameters used in assessment:**
  - Measured: $L_{Aeq,T}$ (source), SEL, L_1, time of day, 1/3 octave spectrum, $L_{residual}$, L_{all}
  - Evaluated: K_i, K_t, (K_d)
  - Calculated: L_d, L_e, L_n, L_{den}.
- **measurement positions and duration of measurements are determined according to:**
  - SIST ISO 1996-2:2017,
  - Pravilnik,
  - Uredba
- **Height of the microphone:**
  - 1.5 m, 4 m, each floor in multi-storey building, at facade!
- **Meteorological conditions:**
  - Shall be measured when eqn. 11 is not satisfied (10 m ☹)
  - For measurement positions close to the source: measured or taken from ARSO (# not accredited)
  - New, expensive equipment
  - Additional personnel - no more one man band
- **Measurement uncertainty:**
  - Lack of analytical skills,
  - Lack of input parameters (long term?, representative?)
  - Calculated for each measurement,
  - Decision rules, domain of the laboratory, not mentioned in the regulation

Implementation of new standard SIST ISO 1996-2:2017 in Slovenia

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- One should not follow the new standard without thought as there are some issues not clear and can lead to misleading results.
- Measurements should be performed using common sense, standard should be used as guidance.
- **SA noise - working group:**
  - Laboratories need guidance
  - Noise mapping based on traffic counting is accreditable with measurement calibration (verification).
  - Predictions, based on emission – propagation models, can not be accredited; (Concerts and events)
  - OA 15 Guidance on reporting (SA template for reports) and the use of accreditation sign (two reports)
  - Can be accredited only for a part of the standard
  - Laboratories can develop their own procedures, however the validation should be thorough.
  - **Laboratories can use models to extrapolate measurements**
  - Official statement of SA is that different assessor should have common practice and criteria, and that standards shall be followed, regardless of how stupid they are.

Slovenia – new regulation

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- **Uredba o mejnih vrednostih kazalcev hrupa v okolju (Uradni list RS, št. 43/2018) 14.6.2018**
  - Sources of environmental noise are defined
  - Line source (?)
  - Limit values based on noise zones and noise sources
  - Mix of environmental and building regulation
  - Exclusion of ships, roads with less then 1 M vehicles per year
  - Additional regulation regarding construction sites and bars
  - Additional regulation regarding companies involved in recycling and waste management
  - Noise assessment can only be performed by laboratories having license form the Environmental Agency
- **Pravilnik o spremembah in dopolnitvah Pravilnika o prvem ocenjevanju in obratovalnem monitoringu za vire hrupa ter o pogojih za njegovo izvajanje**
  - Introduces two year period to adopt the new standard.

Limit values-different zones outdoors and indoors

Preglednica 4: mejne vrednosti kazalcev hrupa L_{dan}, $L_{noč}$, $L_{večer}$ in L_{dvn}, ki ga povzroča naprava, obrat, letališče, ki ni večje letališče, helikoptersko vzletišče, objekt za pretovor blaga in odprto parkirišče:

Območje varstva pred hrupom	L_{dan} (dBA)	$L_{večer}$ (dBA)	$L_{noč}$ (dBA)	L_{dvn} (dBA)
IV. območje	73	68	63	73
III. območje	58	53	48	58
II. območje	52	47	42	52
I. območje	47	42	37	47

- **IV.** območje varstva pred hrupom: površine brez stanovanj in drugih stavb z varovanimi prostori (površine za proizvodno dejavnost, transport, kmetijstvo, gozdarstvo, obrambo)
- **III.** območje varstva pred hrupom: splošne stanovanjske, šolske, športne in druge površine, na katerih so stavbe z varovanimi prostori
- **II.** območje varstva pred hrupom: čiste stanovanjske in turistične površine, površine v okolici bolnišnic in zdravilišč ter mirne površine v naseljih, varovane s posebnimi občinskimi predpisi
- **I.** območje varstva pred hrupom: površine, ki so varovane po zakonu o varstvu narave.

3.2. Preglednica 3**: viri hrupa, ki se nahajajo v stavbi sami** (strojnice, kotlovnice, instalacije, ..)

Preglednica 3:

Namembnost prostora	Mejne ravni hrupa L_{AFmax} [1,2] dB(A)
Varovani prostori v stanovanjih, prenočitvene enote, bolniške sobe	30
Ambulante, ordinacije, operacijski prostori	35
Učilnice, predavalnice, delovni in študijski kabineti, knjižnice, čitalnice ipd.	40

[1] Mejne vrednosti ravni hrupa se nanašajo na opremljene prostore.
[2] Posamezne kratkotrajne konice hrupa, ki nastajajo pri uporabi vodovodnih instalacij in armatur v sosednjih prostorih, se ne upoštevajo.

3.Mejne vrednosti hrupa V STAVBAH

3.1.Pregledica 2: **viri hrupa izven stavbe** (promet, industrija, lokali,..)

Preglednica 2:

Namembnost prostora	Mejne vrednosti ekvivalentnih ravni hrupa L_{Aeq} [1] dB(A)		
	dan	večer	noč [2]
Prostori v stanovanjih	35	33	30
Prenočitvene enote v stavbah za nastanitev (hotelih, motelih, penzionih ipd.) ter sobe v stanovanjskih stavbah za posebne namene (domovi za starejše, dijaški domovi, internati ipd.)	35	33	30
Bolniške sobe	30	30	30
Ambulante, ordinacije, operacijski prostori	35	35	35
Učilnice, predavalnice, delovni in študijski kabineti, knjižnice, čitalnice ipd.	35	35	35

[1] Mejne ravni hrupa se nanašajo na opremljene prostore in standardno absorpcijo".

Measurement of sound insulation parameters in Slovenia

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- ⇒ Measurement methods according to standards SIST ISO 16283-1:2014, SIST ISO 16283-2:2016, SIST ISO 16283-3:2016, SIST ISO 140-4,5,7, SIST EN ISO 717-1,2, SIST EN ISO 3382-1,2 + methods that evaluate sound reduction and absorption of noise barriers

- ⇒ Regulation: Tehnična smernica TSG-1-005-12, Zaščita pred hrupom v stavbah

- ⇒ Limit values for typical structures (compared in Tables on slide 31)

- ⇒ Measurement uncertainty in assessment according SIST ISO 12999-1:2014. It is not taken into account when assessment is done. Some laboratories include uncertainty into decision on sound insulation acceptability.

Limit values for sound insulation parameters in EU countries for typical situations

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Towards a common framework in building acoustics throughout Europe

COST Action TU0901

Table 2.5. Airborne sound insulation between dwellings - Main requirements in 35 European countries[1].

Status June 2013[1]		Multi-storey housing	Row housing
Country[10]	Descriptor[2]	Req. [dB]	Req. [dB]
Austria	$D_{nT,w}$	≥ 55	≥ 60
Belgium	$D_{nT,w}$	≥ 54	≥ 58
Bulgaria	R'_w	≥ 53	≥ 53
Croatia	R'_w	≥ 52	≥ 52
Cyprus (8)	N/A	N/A	N/A
Czech Rep.	R'_w	≥ 53	≥ 57
Denmark	R'_w	≥ 55	≥ 55
England & Wales	$D_{nT,w} + C_{tr}$	≥ 45	≥ 45
Estonia	R'_w	≥ 55	≥ 55
Finland	R'_w	≥ 55	≥ 55
France	$D_{nT,w} + C$	≥ 53	≥ 53
Germany	R'_w	≥ 53 (4)	≥ 57
Greece (9)	R'_w	≥ (50)	≥ (50)
Hungary	$R'_w + C$	≥ 51	≥ 56
Iceland	R'_w	≥ 55	≥ 55
Ireland	$D_{nT,w}$	≥ 53 (4)	≥ 53
Italy	R'_w	≥ 50	≥ 50
Latvia	R'_w	≥ 54	≥ 54
Lithuania	$D_{nT,w}$ or R'_w	≥ 55	≥ 55
Luxembourg (8)	N/A	N/A	N/A
Macedonia FYR (8)	N/A	N/A	N/A
Malta (8)	N/A	N/A	N/A
Netherlands	$R'_w + C$	≥ 52	≥ 52
Norway	R'_w (3)	≥ 55 (3)	≥ 55 (3)
Poland	$R'_w + C$	≥ 50 (4)	≥ 52 (5)
Portugal	$D_{nT,w}$	≥ 50	≥ 50
Romania (6)	R'_w	≥ 51	≥ 51
Scotland	$D_{nT,w}$	≥ 56	≥ 56
Serbia	R'_w	≥ 52	≥ 52
Slovakia	R'_w or $D_{nT,w}$	≥ 53	≥ 57
Slovenia	R'_w	≥ 52	≥ 52
Spain	$D_{nT,A} \approx D_{nT,w} + C$	≥ 50	≥ 50
Sweden	$R'_w + C_{50-3150}$	≥ 53	≥ 53
Switzerland	$D_{nT,w} + C$	≥ 52 (7)	≥ 55
Turkey (8)	N/A	N/A	N/A

Table 2.6. Impact sound insulation between dwellings - Main requirements in 35 European countries[1].

Status June 2013[1]		Multi-storey housing	Row housing
Country[11]	Descriptor[2]	Req. [dB]	Req. [dB]
Austria	$L'_{nT,w}$	≤ 48	≤ 43
Belgium	$L'_{nT,w}$	≤ 58 (3)	≤ 50
Bulgaria	$L'_{n,w}$	≤ 53	≤ 53
Croatia	L'_w (5)	≤ 68	≤ 68
Cyprus (9)	N/A	N/A	N/A
Czech Rep.	$L'_{n,w}$	≤ 55	≤ 48
Denmark	$L'_{n,w}$	≤ 53	≤ 53
England & Wales	$L'_{nT,w}$	≤ 62	None
Estonia	$L'_{n,w}$	≤ 53	≤ 53
Finland	$L'_{n,w}$ (4)	≤ 53 (4)	≤ 53 (4)
France	$L'_{nT,w}$	≤ 58	≤ 58
Germany	$L'_{n,w}$	≤ 53	≤ 48
Greece (10)	$L'_{n,w}$	≤ (60)	≤ (60) 60 info
Hungary	$L'_{n,w}$	≤ 55	≤ 45
Iceland	$L'_{n,w}$	≤ 53	≤ 53
Ireland	$L'_{nT,w}$	≤ 62	None
Italy	$L'_{n,w}$	≤ 63	≤ 63
Latvia	$L'_{n,w}$	≤ 54	≤ 54
Lithuania	$L'_{n,w}$	≤ 53	≤ 53
Luxembourg (9)	N/A	N/A	N/A
Macedonia FYR (9)	N/A	N/A	N/A
Malta (9)	N/A	N/A	N/A
Netherlands	$L'_{nT,w} + C_I$	≤ 54	≤ 54
Norway	$L'_{n,w}$ (4)	≤ 53 (4)	≤ 53 (4)
Poland	$L'_{n,w}$	≤ 58	≤ 53
Portugal	$L'_{nT,w}$	≤ 60	≤ 60
Romania (7)	$L'_{n,w}$	≤ 59	≤ 59
Scotland	$L'_{nT,w}$	≤ 56	None
Serbia	$L'_{n,w}$	≤ 68	≤ 68
Slovakia	$L'_{n,w}$ or $L'_{nT,w}$	≤ 55	≤ 48
Slovenia	$L'_{n,w}$	≤ 58	≤ 58
Spain	$L'_{nT,w}$	≤ 65	≤ 65
Sweden	$L'_{n,w} + C_{I,50-2500}$	≤ 56 (6	≤ 56 (6)
Switzerland	$L'_{nT,w} + C_I$	≤ 53 (8)	≤ 50
Turkey (9)	N/A	N/A	N/A

Noise at workplace-Slovenia

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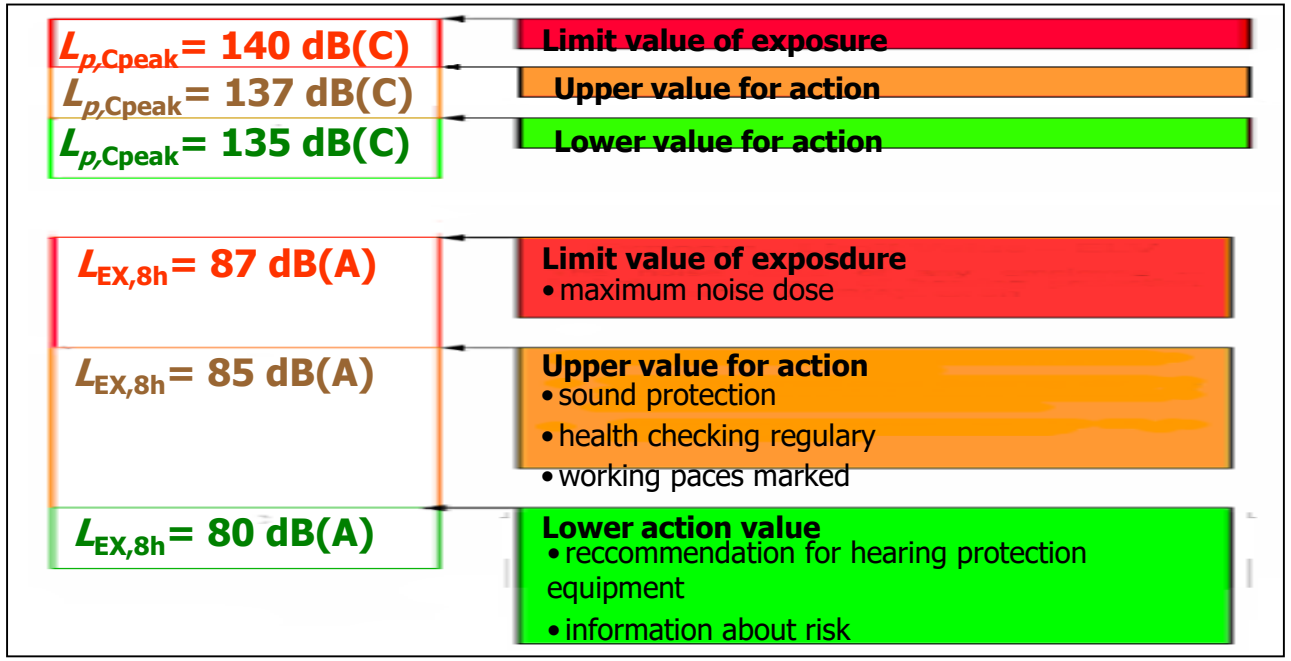
- Regulation:
  - Pravilnik o varovanju delavcev pred tveganji zaradi izpostavljenosti hrupu pri delu, Ur. list RS št. 17/2006
  - Pravilnik o dovoljenjih za opravljanje strokovnih nalog na področju varnosti pri delu (Uradni list RS, št. 2/17)
  - Praktične smernice za varovanje delavcev pred hrupom na glasbenem in razvedrilnem področju (Uradni list RS, št. 96/07)
- Accreditation is not necessary:
  - Ownership or long-term lease of measurement equipment (SLM, calibrator, personal dosimeter)
  - Measurement method
  - Personnel with technical education
  - **Expert exam**



- Measured parameters:
  - $L_{p,A,eqT}$,
  - K_i
  - A-weighted noise exposure level normalized to an 8 h working day daily noise exposure level $L_{EX,8h}$, average or normalized exposure over a number of days;
  - C-weighted peak sound pressure level $L_{p,Cpeak}$

Noise assessment through calculation

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- ⇒ **Noise emission and propagation modelling is equivalent to measurement.**
- ⇒ ILC (SDA) showed that modelling could only be used as an extrapolation of measurement results ?
- ⇒ Monitoring of road and railway noise is performed with calculation methods (XPS and RMR). Measurement (calibration) locations are usually chosen at short distance from the road. ILC showed that traffic noise measurements and propagation modelling by ISO 9613-2 together provide comparable results to pure emission-propagation models like XPS.
- ⇒ Noise propagation from industry noise sources is performed according to ISO 9613-2 and used often to predict future levels. **(Prediction can not be accredited).**
- ⇒ Users like colors (ColorsForDirector), so sound maps are preferred. (Priloga 4 Uredbe – sound maps are produced even for simple sources, for construction sites, ….)

Noise mapping in Slovenia

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- ⇒ Strategic noise mapping is a special case of noise evaluation via computational modelling, that is subject to Directive 2002/49/EC
- ⇒ Its purpose is to systematically collect data related to environmental noise pollution resulting from railway and road traffic, airports or industrial activities in EU member states, and in the EU as a whole
- ⇒ In the first phase (until July 2007), the Directive requires from all Member States to provide strategic noise maps of all major roads with more than 6 million vehicles, railways with more than 60.000 trains, airports with more than 50.000 annual flights, and agglomerations with a population greater than 250.000, all based on 2006 data
- ⇒ The second phase (until the end of 2012 and thereafter every 5 years) requires EU member states to provide noise maps of all major roads with at least 3 million vehicles, railways with more than 30.000 trains, major airports, and agglomerations with more than 100.000 inhabitants, all based on data for previous year
- ⇒ data about noise mapping in Slovenia is collected and exhibited by the Slovenian Environment Agency
- ⇒ **Laboratories have to be accredited according ISO 17025:2005 (2017) with mentioned methods for traffic noise, railway noise, industrial noise. Past references (in Slovenia) have to be shown.**
- ⇒ Action plans are developed based on noise maps. Authorities believe that only noise sources which are a part of the strategic noise maps should be considered.
- ⇒ **Yet there is no correlation between L_{den} (365 day) and percentage of noise annoyed population .**

⇒ Questions?

Slovakia

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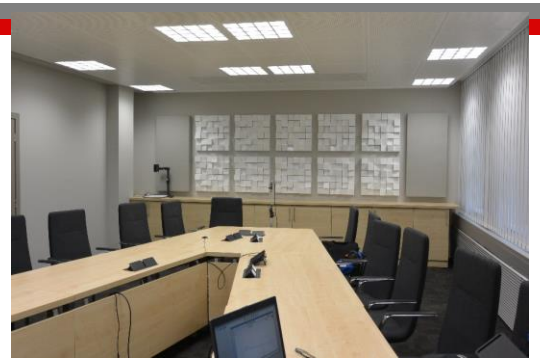
- Dipl. Ing. Peter Zatko, A&Z Acoustics s.r.o., Bratislava, Slovakia
- Slovak company for acoustic measurements and modelling of environmental noise parameters, measurement of sound insulation, room acoustics design, measurement of sound absorption in a reverberation room
- Cooperation on measurements for **strategic noise mapping** (airport noise, traffic noise, railway and industrial noise), **sound insulation measurements** - measurements of sound insulation in buildings - airborne sound insulation, impact sound insulation and facade sound insulation measurements for building properties assessment, building approvals, design of new structures, complaints about unsatisfactory properties of buildings, **room acoustics** - concert halls, churches, shopping areas, classrooms, conference rooms, recording studios, home cinema, rehearsal rooms - measurements, room acoustic design, consulting, **environmental noise measurements** – traffic noise, industrial noise, measurements for building permits, complaints about noisy neighbours, building ventilation and air conditioning technologies, BREEAM noise measurements (Building Research Establishment Environmental Assessment Method)
- **BREEAM** is a sustainability assessment method that is used to masterplan projects, infrastructure and buildings (Energy, Land use and ecology, Water, Health and well-being Pollution (Pol 05 Noise attenuation, Hea 05 Acoustic performance), Transport, Materials, Waste, Management
- Hea 05 - To ensure the building's acoustic performance including sound insulation with reverberation time and indoor ambient noise levels, they should meet the appropriate standards for its purpose;
- Pol 05 - To reduce the likelihood of noise arising from fixed installations on the new development affecting nearby noise-sensitive buildings.

Measurements and modelling






Acoustic measurements according to STN EN ISO 3382-1,2, modelling with CATT Acoustic software – concert halls, churches, shopping areas, conference rooms, recording studios, home cinema, rehearsal rooms ...

Measurements of noise exposure levels at workplaces, for design of hearing protection and design of noise pollution reduction (STN EN ISO 9612:2010)

Sound insulation measurements - field measurements of sound insulation in buildings and building elements - airborne sound insulation, impact sound insulation and facade sound insulation measurements

Environmental noise measurements

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Environmental noise measurements - traffic noise, industrial noise, measurements for building permits, neighbour noise, building ventilation and air conditioning technologies, heat pumps, lifts, etc.

Accreditation procedure in Slovakia for acoustic labs

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- ⇒ Slovak laboratories can be accredited for measurement of environmental noise, noise at workplaces and sound insulation measurements according STN EN ISO/IEC 17025:2005-10 and new standard STN EN ISO/IEC 17025:2017;
- ⇒ **Accreditation is not necessary for measuring noise levels at working places and environmental noise (however some companies and authorities require accreditation – it is not clearly written in the law), there is a discussion about the advantages and disadvantages of accreditation;**
- ⇒ **the permission from Ministry of health is always needed whenever or where noise can harm human health (noise at work, noise in residential buildings, hospitals, schools ...) and in case of building permitting - measurements for authorities.**
- ⇒ Decree Nr.549/2007 of the Ministry of Health of the Slovak Republic laying down details of the **permissible values of noise**, **infrasound and vibration** and requirements for objective objectification of noise, infrasound and vibrations in the environment, Government Regulation Nr.115/2006 of the Slovak Republic on Minimum Health and Safety Requirements for the Protection of Workers from Risks Related to Exposure to Noise;
- ⇒ **New ISO 1996-2:2017 is at this time not a Slovak standard, meteorological conditions should be measured in all measurement situations;**
- ⇒ Almost all labs in Slovakia have a meteorological stations (Vaisala, Lufft, Davis, Thies Clima) and they are used for long term measurements (STN ISO 1996-2) with time recording of values.
- ⇒ Handheld equipment (Testo, Greisinger …) is used for all short term measurements (sound insulation, lift noise, other short time measurements) for informative measurement of temperature, humidity, pressure.

Measuring environmental noise parameters-requirements

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- ⇒ External equipment calibration (every two years for sound level meter, and one year for calibrator and microphone); metrological laboratory TSU Piešťany -.
- ⇒ Measured parameters : $L_{A,eq}$, $L_{AF,max}$, $L_{AS,max}$, are rated; different limit values for day (06:00–18:00), evening (18:00-22:00) and night (22:00-06:00) for indoor environment of buildings and outdoor environment
- ⇒ **Measurement uncertainty must be taken into account**, is given by the Professional guidance of the public health authority on the determination of uncertainty of sound measurement (**typically in range 1,8 – 2,8 dB**, depending on **the frequency characteristics and the directional properties of the sound source**), or can be calculated (according to the Guide to the expression of uncertainty in measurement);
- ⇒ According to Decree Nr.549/2007 of the Ministry of Health of the Slovak Republic laying down details of the permissible values of noise, infrasound and vibration and requirements for objectification of noise, infrasound and vibrations in the environment, **the noise should be measured 1,5 m ± 0,2m in front of façade with closed windows (dwelling houses)**.
- ⇒ In case of absence of the building we measure **in free field conditions and for next calculations we add 3 dB to measured value (question is, if 3 dB is fully correct …)**.
- ⇒ **For family houses the noise should be measured in height 1,5 m above the ground at the border of property**.
- ⇒ Experienced members of labs perform measurement always parallel in two points : in the near field of the source - in the reference point and at the point of assessment.
- ⇒ The regime of noise source operation is controlled at the measurement by a person in the reference point.

Measuring environmental noise parameters

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Kategória územia	Opis chráneného územia	Ref. čas. inter.	Prípustné hodnoty [a] (dB)				
			Hluk z dopravy				Hluk z iných zdrojov $L_{Aeq,p}$
			Pozemná a vodná doprava [b] [c] $L_{Aeq,p}$	Železničné dráhy [c] $L_{Aeq,p}$	Letecká doprava $L_{Aeq,p}$	Letecká doprava $L_{ASmax,p}$	
I.	Územie s osobitnou ochranou pred hlukom (napríklad kúpeľné miesta,[10]) kúpeľné a liečebné areály).	deň večer noc	45 45 40	45 45 40	50 50 40	– – 60	45 45 40
II.	Priestor pred oknami obytných miestností bytových a rodinných domov, priestor pred oknami chránených miestností školských budov, zdravotníckych zariadení a iných chránených objektov,[d]) rekreačné územie.	deň večer noc	50 50 45	50 50 45	55 55 45	– – 65	50 50 45
III.	Územie ako v kategórii II v okolí diaľnic, ciest I. a II. triedy, miestnych komunikácií s hromadnou dopravou, železničných dráh a letísk, [9]) [11]) mestské centrá.	deň večer noc	60 60 50	60 60 55	60 60 50	– – 75	50 50 45
IV.	Územie bez obytnej funkcie a bez chránených vonkajších priestorov, výrobné zóny, priemyselné parky, areály závodov.	deň večer noc	70 70 70	70 70 70	70 70 70	– – 95	70 70 70

Limit values according to different zones for noisy area

Category I. : Territory with special noise protection (spa areas, curative areas)

Category II. : Space in front of residential living room windows, in the vicinity of family houses, in front of protected school building facades, medical buildings, recreational territory.

Category III. :
Territory as in category II, but near a motorway, I. and II. Class roads, local communications with bulk passenger traffic, railways and airports, urban centers.

Category IV. :
Territory without habitation functions, industrial zone

Decree Nr.549/2007 of the Ministry of Health of the Slovak Republic laying down details of the permissible values of noise, infrasound and vibration and requirements for objective objectification of noise, infrasound and vibrations in the environment

Measuring sound insulation parameters

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⇒ Sound insulation parameters in Slovakia are measured according to STN EN ISO 16283-1,2,3

⇒ Required minimal sound insulation values for different types of buildings (residential, family houses, hospitals, schools, hotels, office buildings) are defined by national standard STN 73 0532:2013;

⇒ The national standard STN 73 0532:2013 recommends expressing the reproducibility of measurements or the uncertainty of the measurements as follows : **test report may contain information about uncertainty as useful supplementary information, but it does not affect assessment of the building structure according to this standard**.

⇒ The measured value is compared to the required value specified in this standard:

Required values for sound insulation

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Limit values for sound insulation parameters in Slovakia :

Building acoustics throughout Europe - Volume 1:
Towards a common framework in building acoustics throughout Europe

COST Action TU0901

Table 2.5. Airborne sound insulation between dwellings - Main requirements in 35 European countries[1].

Status June 2013[1]		Multi-storey housing	Row housing
Country[10]	Descriptor[2]	Req. [dB]	Req. [dB]
Croatia	R'_w	≥ 52	≥ 52
Slovenia	R'_w	≥ 52	≥ 52
Slovakia	R'_w or $D_{nT,w}$	≥ 53	≥ 57
Austria	$D_{nT,w}$	≥ 55	≥ 60

Table 2.6. Impact sound insulation between dwellings - Main requirements in 35 European countries[1].

Status June 2013[1]		Multi-storey housing	Row housing
Country[11]	Descriptor[2]	Req. [dB]	Req. [dB]
Croatia	L'_w (5)	≤ 68	≤ 68
Slovakia	$L'_{n,w}$ or $L'_{nT,w}$	≤ 55	≤ 48
Austria	$L'_{nT,w}$	≤ 48	≤ 43

... the strictest criteria are valid in Austria

Noise at workplace in Slovakia

Hrvatsko akustičko društvo
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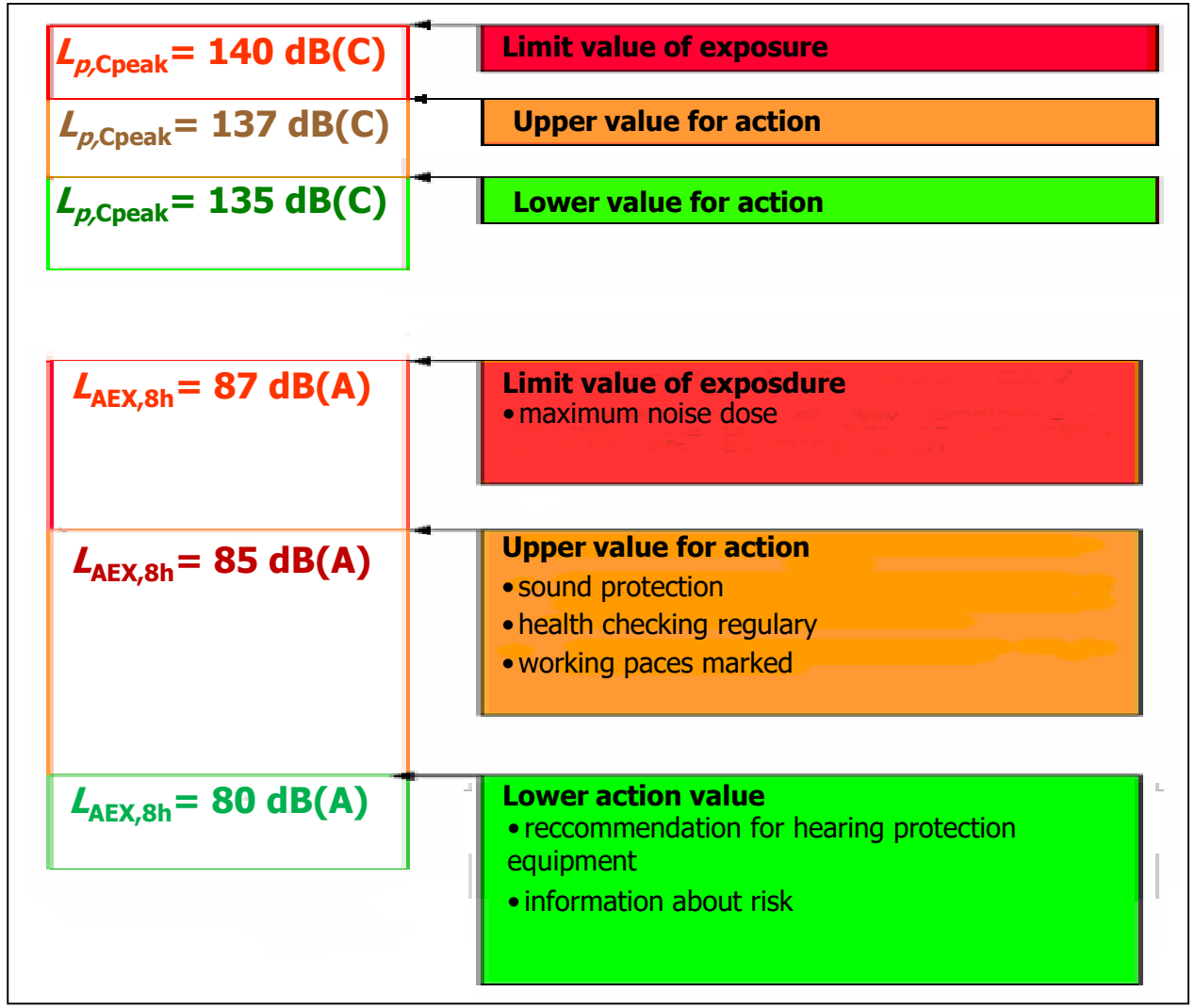
- For measurement methods according to STN EN ISO 9612:2010, STN ISO 1999:1993, STN EN ISO 4869-2:1998 accreditation in Slovakia is not necessary (**it is not clearly written in the law, measurements are performed by accredited and non-accredited companies, many times more accurate and more correct measurements are performed by non-accredited companies**)
- Measured parameters: A-weighted equivalent continuous sound pressure level $L_{p,A,eqT}$, evaluated values *:* A-weighted noise exposure level normalized to an 8 h working day - daily noise exposure level $L_{A,EX,8h}$, normalized exposure over a number of days; C-weighted peak sound pressure level $L_{p,Cpeak}$
- Limit values in Slovakia are the same as in Croatia :



Noise mapping in Slovakia

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⇒ The strategic noise mapping in Slovakia was made for year 2006 and 2011, according to EU 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 - Declaration by the Commission in the Conciliation Committee on the Directive relating to the assessment and management of environmental noise

⇒ Noise mapping was performed for all agglomerations with more than 250 000 inhabitants (Bratislava and Košice) and for all major roads which have more than six million vehicle passages a year, major railways which have more than 60 000 train passages per year and major airports within their territories + industrial noise sources.

⇒ The result of strategic noise mapping in Slovakia can be found here : http://www.hlukovamapa.sk

Croatia

Hrvatsko akustičko društvo
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- **Regulations:** law and different regulations (Zakon o zaštiti od buke (NN 30/09, 55/13, 153/13, 41/16), Pravilnik o najvišim dopuštenim razinama buke u sredini u kojoj ljudi rade i borave (NN 145/04), Pravilnik o djelatnostima za koje je potrebno utvrditi provedbu mjera za zaštitu od buke (NN 91/07), Pravilnik o uvjetima glede prostora, opreme i zaposlenika pravnih osoba koje obavljaju stručne poslove zaštite od buke (NN 91/07), Pravilnik o stručnom ispitu iz područja zaštite od buke (NN 91/07), Pravilnik o načinu izrade i sadržaju karata buke i akcijskih planova te o načinu izračuna dopuštenih indikatora buke (NN 75/09), Pravilnik o mjerama zaštite od buke izvora na otvorenom prostoru (NN 156/08);
- Number of different laboratories: 23 for environmental noise and 23 for sound insulation (with accreditation and permission of Ministry of health);
- Laboratories don't have to have accreditation in the field of measurement noise at workplace;
- For calculation methods (traffic noise and industrial noise mapping, prediction) they don't have to have accreditation according ISO 17025, just permission given by Ministry of Health (but they have to have accreditation for basic acoustic measurements).
- For some calculation projects and court cases, the company/labs does not have to have permission and accreditation, just software and educated personnel (depend on the contest)
- Ministry of health (for environmental noise parameters and sound insulation) and Ministry of labour (noise at workplace).

About new ISO 1996-2:2017

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- ⇒ This standard edition is **more complex** than previous version ISO 1996-2:2007;
- ⇒ Each measurement occasion can be subjected to **different operating conditions** from source and **different meteorological conditions** so measurement uncertainty can not be controlled by operator;
- ⇒ Cover all types of sources (traffic, industry) and meteorological conditions (favourable, very favourable neutral and unfavourable);
- ⇒ **More complex way to calculate measurement uncertainty**, dividing work of source in different operating and meteorological conditions;
- ⇒ For some meteorological conditions (unfavourable) results have to be omitted (problems with short term measurements on larger distance than eq. 11)
- ⇒ **The process of measurement uncertainty estimation is much more complicated** (influence of all parameters, equipment, repeatability conditions, different operating and meteorological windows);
- ⇒ The standard **wants to cover all possible conditions** but it is basis for developing **more specific standards** dedicated to the specific type of sound sources and aims;

New ISO 1996-2:2017-remarks

Hrvatsko akustičko društvo
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- ⇒ Long term unattended measurements and short term attended measurements, precision and accuracy of instruments, wind speed and direction should be measured at 10 m having purpose to separate results in different meteorological windows;
- ⇒ Independent measurements-time difference;
- ⇒ Reference conditions (when traffic noise is measured)
- ⇒ The standard is more **oriented to traffic measurements** than ordinary measurement of classical industrial sources at small distance;
- ⇒ **The majority of laboratories do not have equipment for measuring meteorological conditions every 1 s with precision and accuracy (wind direction 5 degrees);**
- ⇒ It is unlogical to measure meterological parameters at 10 m when there is small influence of meterological conditions on sound propagation, just at the height of microphone (check self-noise due to wind)

Implementation of new standard HRN EN ISO 1996-2:2017 in Croatia

Hrvatsko akustičko društvo
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- ⇒ The assessing procedure from new ISO 1996-2:2017 started after 01.09.2018;
- ⇒ **Short instruction** is prepared in accordance with requirements from ISO 1996-2:2017 and ISO 1996-1:2016;
- ⇒ Measurement of meteorological parameters and determination of meteorological windows are much more complex at distances for which equation (11) is not fulfilled;
- ⇒ Influence of meteorological parameters **in favourable conditions on measurement uncertainty is u=2 dBA**, much more than in previous standard ISO 1996-2 (0,5 dB) for even simple situation with small distance from the source;
- ⇒ more description about measurement positions (free field, on the facade and near facade);
- ⇒ Is the 0,5 m in front of the facade specific position out of accreditation procedure (there is no correction for specific position)?;
- ⇒ Tonal and impulse sound corrections are now better explained in standard and national bylaw but labs have different approaches;
- ⇒ If measurements can't be done due to the influence of the background noise than closer position is chosen but full calculation has to be done in accordance with ISO 9613-2:1996 **to estimate sound pressure level at desired position** (not just simple divergence correction but all effects should be considered);

Problems in Croatia (environmental noise)

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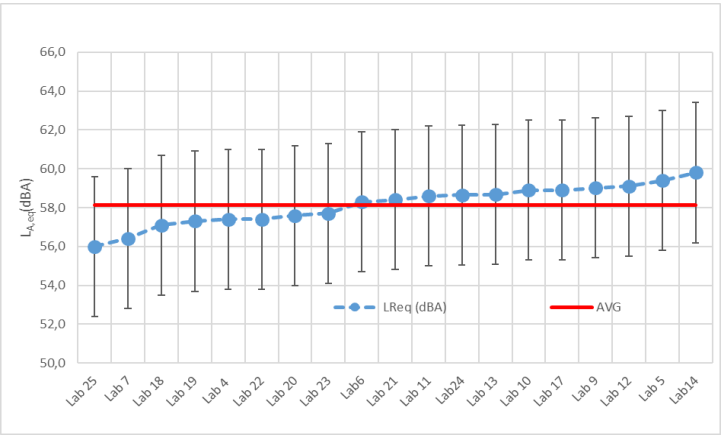
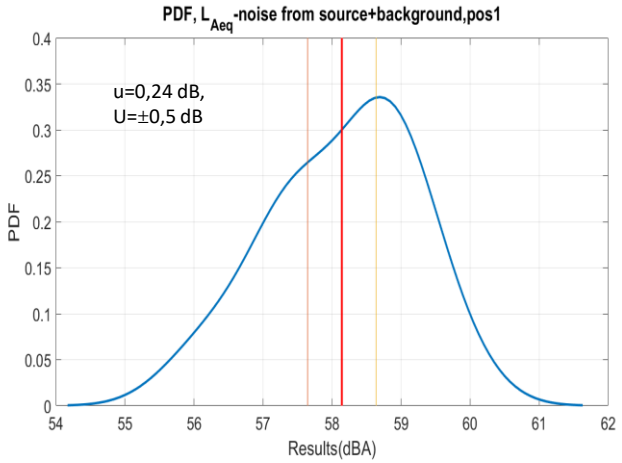
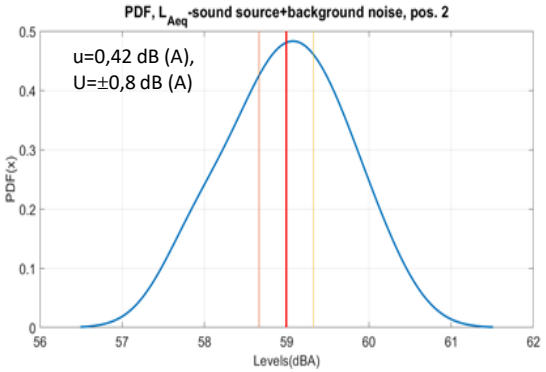
- ⇒ Definition of limit values in zones, the names of sound zones are not equal with names in urbanistic plans (different people don't cover the all problem);
- ⇒ 1 dBA rule has to be uses if the background noise is smaller or higher than proposed in national legislative if the zone is not known? (Pravilnik o najvišim dopuštenim razinama buke u sredinama u kojima ljudi rade i borave NN 145/2004)
- ⇒ Measurement position is 0,5 m in front of the open gap, toward the source, very often it is not possible to choose this position and inspectors insist so the labs are measuring on other positions (on the facade or close to facade) and write that they have measured 0,5 m in front of the facade;
- ⇒ Operating conditions seems to be very problematic also because owners are manipulating with the sources;
- ⇒ There are no calculations of sound descriptors (L_{day}, L_{night}, L_{den})?
- ⇒ Some measurements should be done over the year (average operating and propagation conditions) but the investor does not have enough money to cover these kind of measurements (choose representative interval of time);

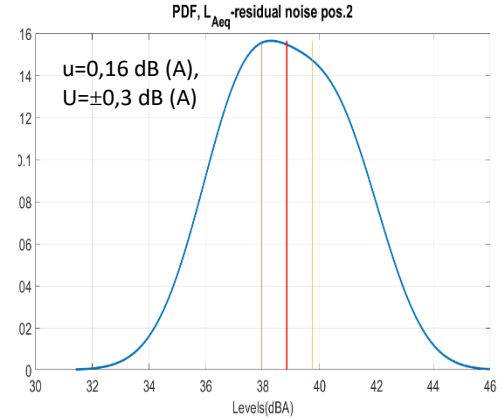
Comparison of the measurement results and uncertainty estimation according old ISO 1996-2:2008 and new ISO 1996-2:2017

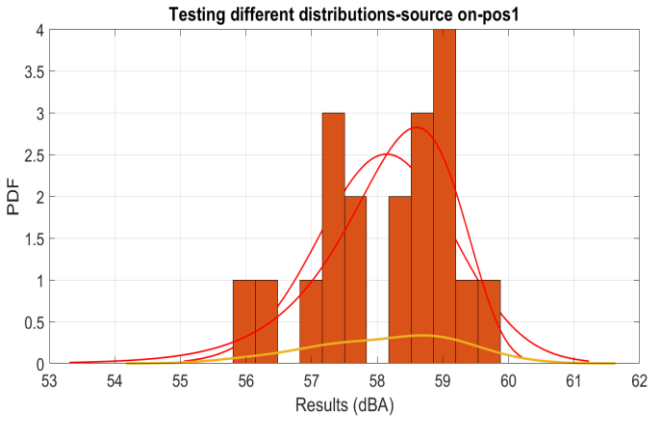
- ⇒ The same example with two different approaches:
- ⇒ $L = L' + \delta_{slm} + \delta_{sou} + \delta_{met} + \delta_{loc} + \delta_{res}$
- ⇒ $u = \sqrt{1^2 + X^2 + Y^2 + Z^2}$

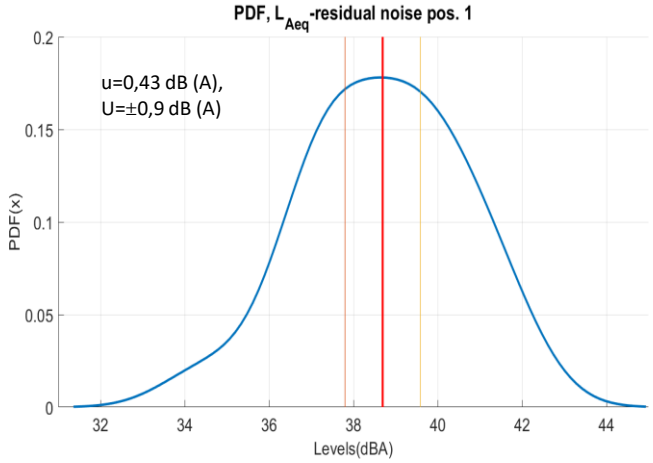












Situation/ Parameter	Arithmetic mean (dBA)	U_k (dBA)	Logarithmic mean (dBA)	U_k (dBA)	Max PDF (dBA)
Residual noise-pos1	38,7	0,9	39,1	1,5	38,8
Source -pos1	58,1	0,5	58,3	1,4	58,7
Residual noise-pos2	38,9	0,9	39,2	1,5	38,3
Source -pos2	59,0	0,3	59,1	1,4	59,1

Measurement uncertainty calculation

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- ⇒ Old standard, each lab, Y=1,5 dB(A), and X and Z approximately 0, expanded uncertainty (two side interval, 95 % confidence level);
- ⇒ New standard ISO 1996-2:2017 calculations (standard deviations of the mean not standard deviations);
- ⇒ u_{res}=2 dBA in standard ISO 1996-2:2017??? ($L_{A,95}$ only for traffic)

Quantity	Estimate	Standard Uncertainty	Senistivity Coefficient	Uncertainty Contribution
$L'_{A,eq}$ + ϱ_{slm}	58,3	0,5	1,01	0,51
ϱ_{sou}	0,0	**0,3**	1,00	0,28
ϱ_{met}	***0,0***	***2,0 (1,5)***	***1,00***	***2,00 (***
ϱ_{loc}		0,0	0,00	0,00
ϱ_{res}		0,4	-0,01	-0,01
$L_{A,eq,res}$	39,1			
$u=sqrt(u_1^2+u_2^2+..)$				2,08
$L_{A,eq,\ corrected}$	58,2		Expanded k=2	U=±4,2 (±3,2)

Measurement uncertainty for assessment of the results-environmental noise

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- ⇒ Complex calculation of measurement uncertainty with sensitivity coefficients;
- ⇒ According to calculations in new ISO 1996-2:2017 the standard uncertainty for A-weighted equivalent sound pressure level is minimally u>2dB and the expanded (k=2, 95% confidence interval) measurement uncertainty is U>4 dBA;
- ⇒ According to ILC the expanded measurement uncertainty of valid results (without outliers) the expanded measurement uncertainty for this simple (neglecting tonal penalty due to standing waves) is lower than 1 dBA.
- ⇒ The sensitivity of ear and rule in Croatia is that new sound source must not increase the overall level of residual noise more than +1 dBA;
- ⇒ Should we report so large measurement uncertainty and use it in assessment of new sound source?;

Sound insulation measurements in Croatia

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- ⇒ The majority of labs are accredited for sound insulation measurements according ISO 16283-1:2015, ISO 16283-2:2016, ISO 16283-3:2016;
- ⇒ Measurement uncertainty is calculated according ISO 12999-1:2014 from standard deviation in reproducibility conditions obtained from interlaboratory comparison in 2015;
- ⇒ Standard deviations in repeatability conditions are averaged from large number of interlaboratory comparisons;
- ⇒ **There is possibility to calculate measurement uncertainty from each individual measurement as described in some scientific papers (Maschimbarenna 2015)** but there is **a problem when only one (rotating microphone) measurement** has to be done for each sound source position);
- ⇒ **Unknown correlation coefficients** between one-third octave sound insulation parameters;
- ⇒ Full correlation is assumed but this overestimate single number measurement uncertainty;
- ⇒ Find correlation coefficients between one-third octave band results;

Measurement uncertainty for assessment of the results-sound insulation

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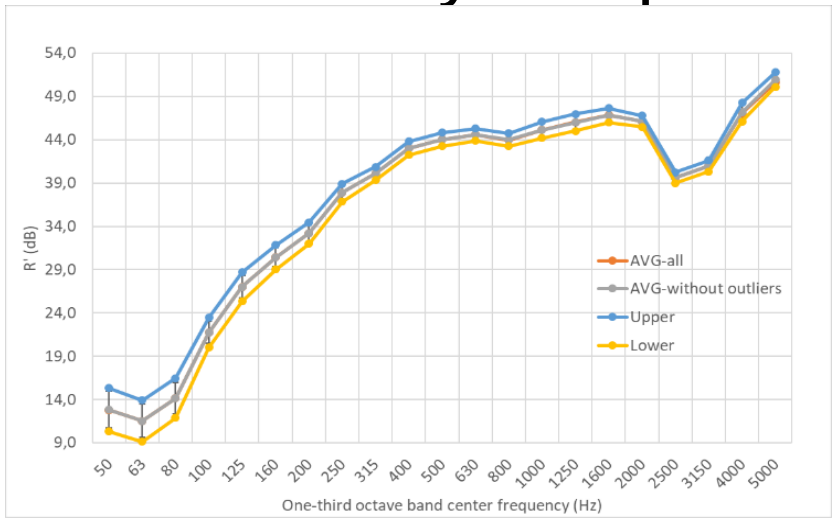
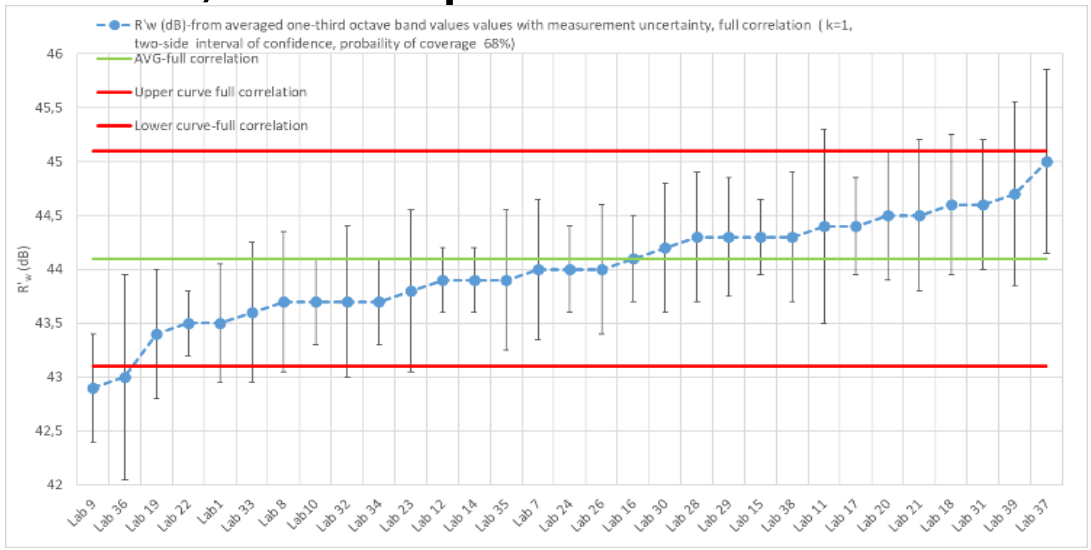
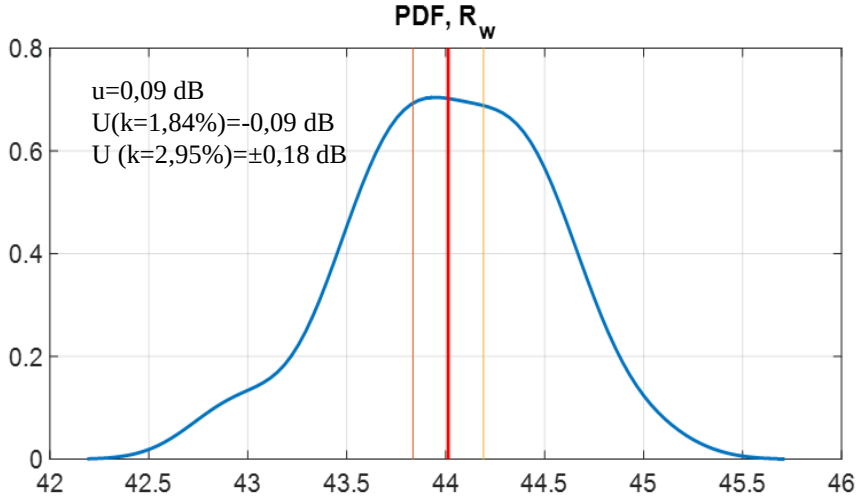
⇒ Interlaboratory comparison (31 labs, 5 independent measurements)







Parameter	Standard deviations in reproducibility conditions from ILC	Standard deviations in reproducibility conditions from standard ISO 12999-1:2014
R'_w	-1,0	-1,5
R'_w+C	-1,0	-1,8
R'_w+C_{tr}	-1,5	-2,3
$R'_w+C_{50-5000}$	-1,5	-2,8
$R'_w+C_{tr,50-5000}$	-2,0	-3,5

Impact sound insulation measurements

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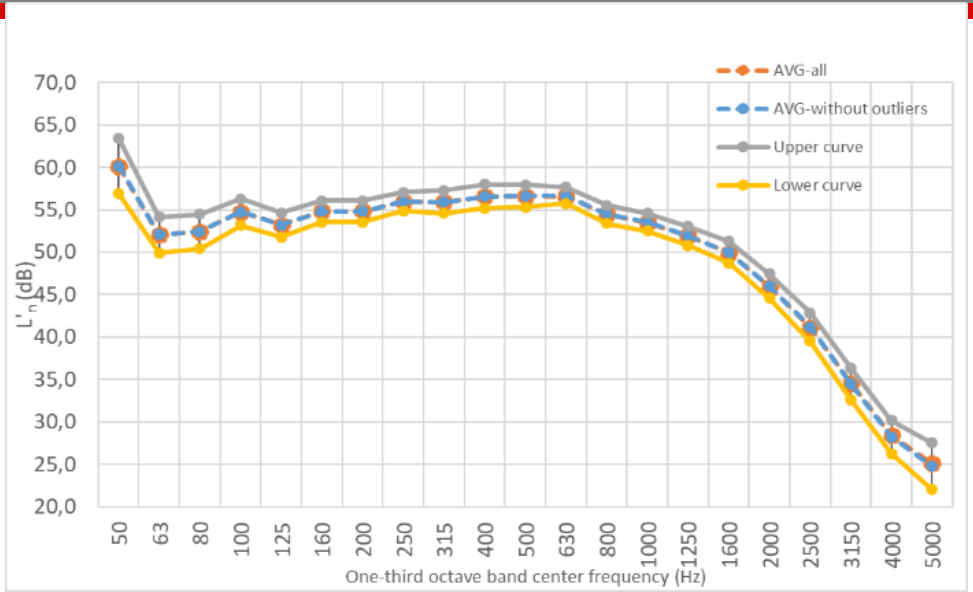

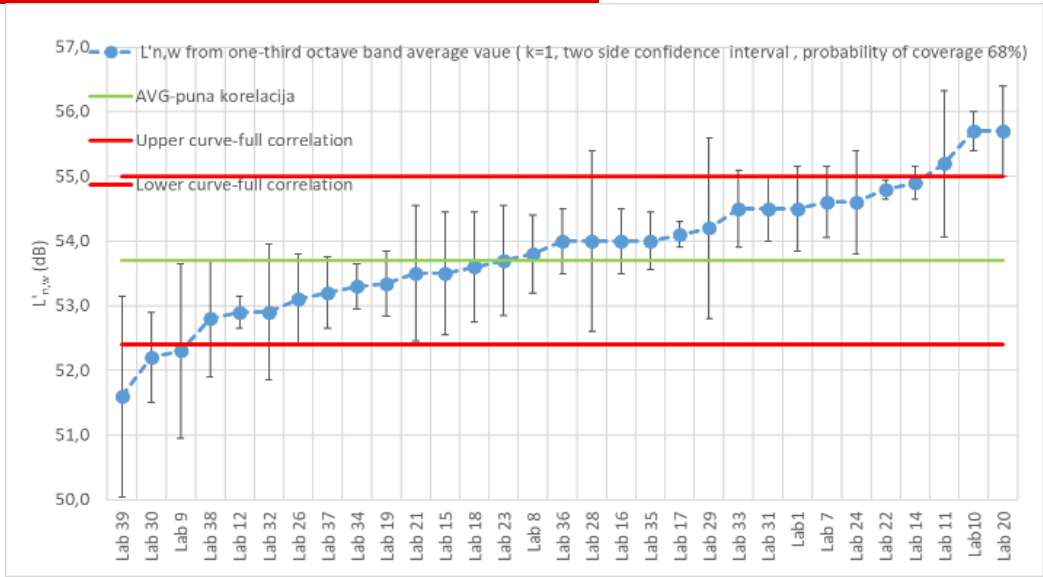

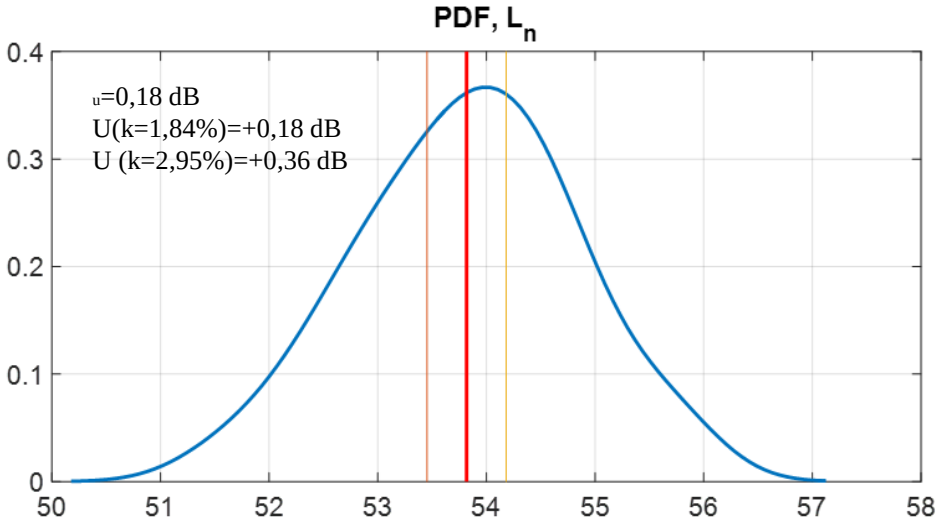

Parameter	Standard deviations in reproducibility conditions from ILC	Standard deviations in reproducibility conditions from standard ISO 12999-1:2014
$L'_{n,w}$:	+1,3	+1,3
$L'_{n,w}+C_i$	+0,8	+0,8
$L'_{n,w}+C_{i,50-2500}$	+1,3	+1,3

Noise at workplace measurements in Croatia-ministry of working

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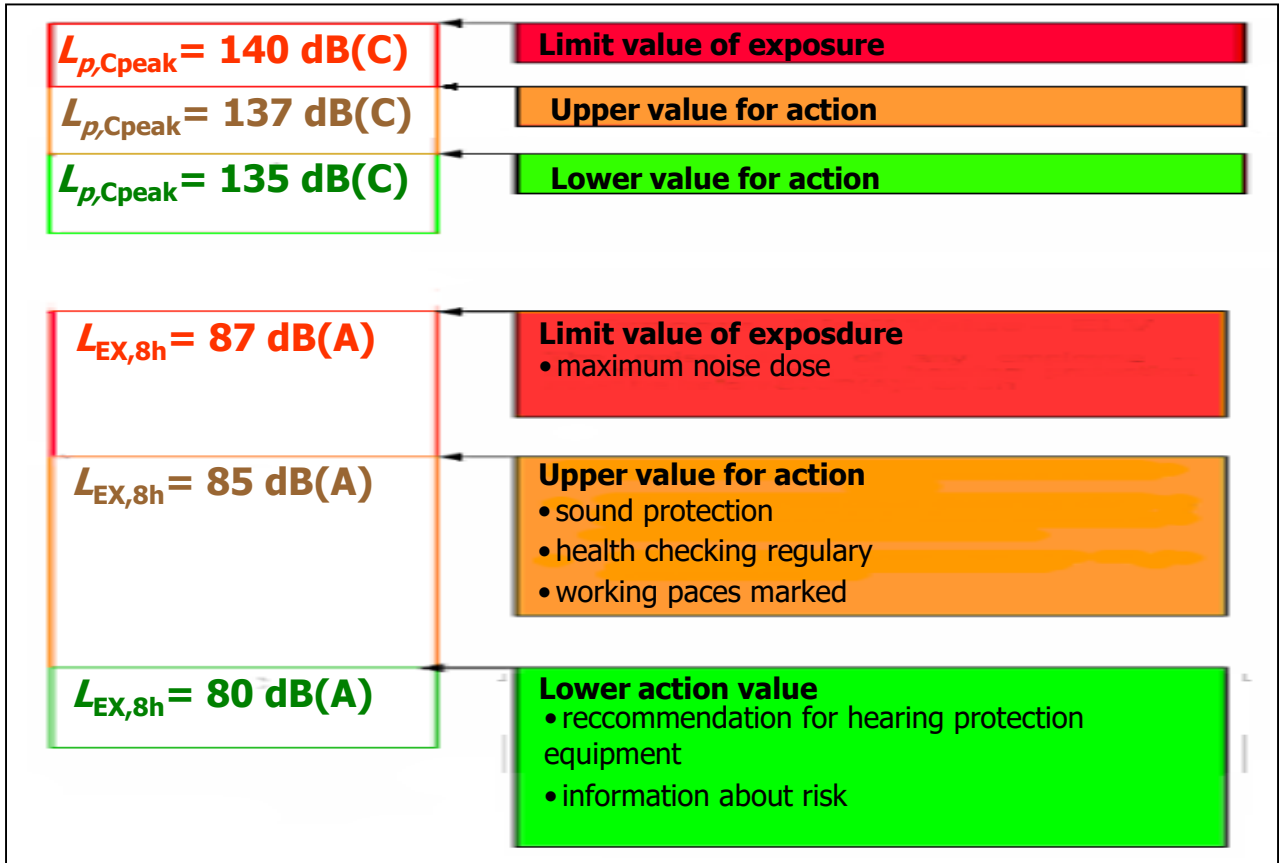
⇒ Measurements according ISO 9612:2009 and passement according national bylaw;

⇒ Parameters: A-weighted equivalent continuous sound pressure level $L_{p,A,eqT}$, A-weighted noise exposure level normalized to an 8 h working day daily noise exposure level $L_{EX,8h}$, average or normalized exposure over a number of days; C-weighted peak sound pressure level $L_{p,Cpeak}$



Noise mapping in Croatia

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- In Croatia, 3 laboratories have approval from the competent authority, Ministry of Health, to make strategic noise maps and action plans
- As part of their work, they also have accreditation according ISO 17025:2005 (2017)
- Ordinance on the method of preparation and content of noise maps and action plans and on the method of calculating limit values of noise indicators (OG 75/09) - determines the method of preparation and content of noise maps and action plans and the method of calculating the values of noise indicators
- **Calculation methods:** road traffic noise (NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB), XPS 31-133), railway noise (Rekenen Meetvoorschrift Railverkeerslawaai '96, Ministerie Volkshuisvesting, Ruimtelijke Ordening en Milieubeheer, 20. studenoga 1996), aircraft noise (ECAC.CEAC Doc. 29) and industrial noise (ISO 9613-2:1996);
-

Noise mapping in Croatia

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⇒ **DIRECTIVE 2002/49/EC relating to the assessment and management of environmental noise (END)**

Is meant to achieve: A common approach to avoid, prevent or reduce on a prioritised basis the harmful effects, including annoyance, due to exposure to environmental noise

By: Determination of exposure (noise mapping)

Information and involvement of the public

Adoption and implementation of noise action plans

Common noise indicators for the preparation of strategic noise maps are:

L_{den} (day + evening + night) - to assess annoyance and

L_{night} - to assess sleep disturbance

⇒ Common assessment methods for the determination of the noise indicators are established in the **DIRECTIVE (EU) 2015/996 establishing common noise assessment methods** (CNOSSOS) → Member States are required to use these methods from 31 December 2018 onwards

Noise mapping in Croatia

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⇒ 1st reporting round of the noise mapping and action planning (2007) was not obligatory for Croatia, because Croatia became a member of the EU in 2013

⇒ So, we started with the 2nd reporting round (2012 and every 5 years) which requires strategic noise maps and action plans for all major roads which has more than 3 million vehicle passages a year, major railways which has more than 30 000 train passages a year, major airports which has more than 50 000 movements and agglomerations with more than 100.000 inhabitants, all based on data for previous year

⇒ Administrative responsibility for the END in Croatia:

Role	Agglomerations	Roads	Railways	Airports
Producing and approving strategic noise maps and action plans	• City of Zagreb • City of Split • City of Rijeka • City of Osijek	• Croatian Motorways (HAC) • Croatian Roads (HC) • Motorway Rijeka – Zagreb (ARZ) • Motorway Zagreb – Macelj (AZM)	Croatian Railways (HŽ)	Croatian Civil Aviation Agency (no major airport in Croatia which has more than 50 000 movements per year)
Collecting and reporting to the European Commission	Ministry of Health			

⇒ Strategic noise maps and action plans in Croatia have been produced by using “interim” methods provided in Annex II of the END Directive and Recommendations 2003/613/EC

Noise source/type	Method
Road	French NMPB
Railway	Dutch RMR
Aircraft	international ECAC
Industrial	ISO 9613-2

Noise mapping in Croatia

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⇒ Strategic noise maps for 2nd reporting round (year 2012) are available at:

http://buka.azo.hr/

⇒ 3rd reporting round will use CNOSSOS in year 2022

Conclusion

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- ⇒ Comparison between different countries and approaches;
- ⇒ Questions and suggestions for future work in the field of accreditation, legislation and technical part;
- ⇒ Future interlaboratory comparisons will be organized soon, in 2019,, (environmental noise parameters with meteorological parameters monitoring for accredited labs which will be measuring at larger distances and for laboratories which are not able to determine radius of curvature, measuring);
- ⇒ Sound insulation measurements and verification procedure by finding the standard deviations in repeatability and reproducibility conditions;
- ⇒ Usage of obtained results having purpose to estimate measurement uncertainties;

Acknowledgement

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⇒ **RISE project "PapaBuild"** Advanced **p**hysical-**a**coustic and **p**sycho-**a**coustic diagnostic methods for innovation in **build**ing acoustics (in short "PapaBuild") has received funding from the European Union's Horizon 2020 research and innovation Programme under the Marie Skłodowska-Curie grant-agreement No 690970;

⇒ https://www.papabuild.eu/