



norden

Nordic Innovation Centre

POSITION PAPER

Nordic workshop on harmonizing of indoor sound limits

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Participants from all Nordic countries

Summary

The new EU Directive 2002/49/EC relating to the assessment and management of environmental noise [1] is being implemented in the Nordic countries. Regulations on strategic noise mapping and action plans are introduced in Nordic countries in accordance with the Directive. The national degree of implementation in regulations differs, but all five countries are introducing the new noise indicators, A-weighted day-evening-night sound pressure levels, L_{den} , and A-weighted night SPL, L_{night} . Denmark, Finland, Iceland and Sweden will introduce these indicators for noise mapping purposes only, whilst Norway also introduces the new indicators and additional annoyance noise indicators in other regulations, i.e. in revised noise guidelines for area planning within the scope of Planning and Building Act [2, 3]. The present situation is described in this paper.

The splitting up of the twenty-four hours into day, evening and night periods in accordance with the Directive is set to 12 h, 4 h and 8 h, i.e. to daytime 07-19, evening 19-23 and night to 23-07. In Denmark and Finland the evening is set to 19-22 and night 22-07. The knowledge of consequences on traditional construction works, planning and building structures, if the rated yearly day-evening-night sound level is used instead of continuous 24-hour equivalent SPL, $L_{pA,eq,T}$, are not clear. In addition, knowledge of functional changes due to splitting up the day and night time in a new manner is still limited.

The indoor noise level limits or guidelines, currently given as values of $L_{pA,eq,T}$ and L_{pAFmax} , are not planned to be changed in accordance with the Directive. Other ways of expressing indoor noise levels, e.g. in terms of sound insulation requirements are considered in some of the Nordic countries. The European countries do not give indoor noise limits from outdoor sources in the way it is practised in the Nordic countries.

1. Introduction

The national implementation of EU Directive 2002/49/EC relating to the assessment and management of environmental noise [1] is going on in the Nordic countries. Additionally, the revised ISO 1996-1 and -2 [4, 5] include source corrections based on noise annoyance. Noise zone mapping and external noise limits are given by indicators L_{den} and L_{night} , i.e. different weighting of day, evening and night. There is an ongoing harmonization of the prediction methods, too.

Indoor sound conditions/noise limits are today given as A-weighted equivalent continuous and/or maximum sound pressure levels $L_{pA,eq,T}$ and L_{pAFmax} in the Nordic countries (except Finland and Denmark where L_{pAFmax} is not used). Comparison of outdoor and indoor noise levels may not be made directly when the new outdoor indicators and source corrections are established. This will cause confusion about calculation and assessment of indoor values on the basis of outdoor noise values. Variable weighting of different external noise sources (source corrections based on annoyance) may lead to variable evaluation of planning and building construction work.

The day, evening and night periods given in the EU Directive, are different from the ones presently used in the Nordic countries. It has also been proposed to change from the present hours 06-18 (day), 18-22 (evening) and 22-06 (night) to hours 07-19 (day), 19-23 (evening) and 23-07 (night), at least in Norway. The reasons are that statistical studies on people's lifestyle in Norway show that the way of living in the population has changed, and that the distribution of activities during twenty-four hours has shifted (people go to the bed later and get up later) [6]. Consequences of the changes in day-evening-night hours on building construction work and building traditions, especially when the night time maximum noise levels and the evening period are considered, need to be studied.

The noise limits and quantities for evaluating acoustic properties of constructions today are based on common Nordic work in the Nordic Committee for Building regulations, operating since 1978 [7, 8]. An important reason for this is that the building constructions in the Nordic countries are comparable. Since then the limit values have been harmonized in Nordic countries at several revisions of regulations. Since 1995, system for sound classification of dwellings has been discussed in a common Nordic standardization group in INSTA [9]. Later national classification standards have been prepared in Denmark, Iceland, Norway and Sweden [10, 11, 12, 13, 14]. A common discussion and clarification of the situation seem accordingly desirable.

2. Objective for the workshop

The aim of the workshop was to clarify the state of art for various regulations, guidelines and sound classification standards etc. giving requirements for indoor noise conditions from outdoor sources. In order to have a wide basis for conclusions, representatives for both responsible authorities on building, health or environmental sound conditions and acoustical experts were invited to the workshop.

The following items were the basic for discussions in the workshop:

- Should the indoor noise limits for outdoor noise sources be given as A-weighted day-evening-night rating levels, L_{den} , instead of A-weighted continuous equivalent sound pressure levels, $L_{pA,eq,T}$, and as A-weighted night-time rating level, L_{night} in addition to the A-weighted maximum sound pressure level, L_{pAFmax} ? If so is the case, how should these changes be performed? Do we have sufficient knowledge of the technical matters and consequences?
- Should the changes be done equally in Nordic countries? Are common, comparable noise indicators and limits for determination of indoor sound conditions still desirable in Nordic countries? If so, in which way?
- How should calculations, possible corrections and transfer from outdoor noise conditions to indoor sound conditions be handled?
- Should the determination of twenty-four hour sound levels be changed to day-evening-night rating levels at indoors in Nordic countries? If so, what may the consequences be?

3. Indoor noise levels from outdoor sources in Nordic countries - State of the art

Noise conditions in the Nordic countries are stated in different regulations that may have partly overlapping requirements. The regulations for environmental or indoor noise conditions are prescribed by health, building and environmental authorities and are stated in guidelines for land use plans, building regulations, guidelines or regulations for health assessment etc. In Table 1 an overview of the main requirements is given.

3.1 Finland

The implementation of the EU Directive is made as an amendment of the Environmental protection Act (RP 170/2003 rd), in 25 a § (Bullerutredningar och handlingsplaner för bullerbekämpning) and 25 b § (Utarbetande av bullerutredningar och handlingsplaner för bullerbekämpning) [15, 16, 17]. The amendment is accepted at this writing stage. The implementation includes the noise indicator L_{den} , yearly meteorological conditions, evaluation height (4 m) and transforming of national calculation methods. A broader adaptation of the European indicators in the Finnish regulations is assessed after having collected experience from the first phase of noise mapping in accordance with the EU Directive.

In the Finnish guidelines for land use plans, the sound insulation requirements are presented as noise level difference between outdoors and indoors, $\Delta L = L_{out,A,eq} - L_{in,A,eq}$, where ΔL is the sound level difference (requirement in land use plan), $L_{out,A,eq}$ the equivalent outdoor noise level and $L_{in,A,eq}$ the target level for equivalent indoor noise. The guidelines for dwellings are 35 dB in daytime (07-22). In addition, the airborne sound reduction index for the façade elements may be determined by using formulae $R_{A,tr} = R_{tr,needed} + K2$ with given corrections depending on proportional sum area of the façade element.

The Finnish Building Code contains mandatory regulations and guidelines for sound insulation and noise abatement in buildings [18, 19]. The methods applied to prove the compliance with the requirements have to be presented (e.g. by using EN and ISO standards). The regulations contain limits for A-weighted equivalent sound pressure level $L_{pA,eq,T} = 45$ dB outside dwelling (near window, balcony etc.) caused by HVAC equipment in the building. There are no specific indoor level limits for noise from other outdoor sources in this Code. Instead, the noise level difference between outdoors and indoors is considered for determination of façade insulation.

The Finnish method that is used for determining sound insulation requirements for building facades, aims to ensure that the required minimum sound level difference between outside and inside is achieved for the majority of buildings. Target values for indoor noise levels, as given in the guidelines for land use plans, are used as the basis. The requirement is traceable from the noise level difference of facade or from the outdoor sound level. In this way it is possible to select façade components and specify their sound insulation at an early stage of the designing, and to show that the building shell fulfils the requirement.

3.2 Denmark

The Danish Agency on Environmental Protection has prepared a Proposal for announcement on mapping of external noise [20]. The proposal contains quantities L_{den} and L_{night} . The 24-hour-period is defined to be day (07-19), evening (19-22) and night (22-07). Each period is defined for the average over a whole year. The receiver heights are 1,5 m and 4,0 m. The current external noise limits will be transformed from $L_{pA,eq,T}$ values to L_{den} and studies on this have been made [21]. The formula for calculation of the day-evening-night level, is as follows:

$$L_{den} = L_{pA,eq,24h} + 10 \lg \left[\frac{p_d}{100} + \frac{p_e}{100} \sqrt{10} + \frac{p_n}{100} 10 \right] \text{ dB}$$

The percentage of traffic during day (p_d), evening (p_e) and night (p_n) may be used for the conversion. An average correction between $L_{den} - L_{pA,eq,24h}$ for urban road and railway traffic noise has been found to be approx. 5 dB, including the meteorological average for the whole year.

Current indoor noise limits in Denmark are given for traffic noise (30 dB) in building regulations [22] and in Danish Standard DS 490 for sound classification in Class A to D (20/25/30/35 dB) [10]. The Danish authorities are not presently proposing any changes in the requirements for indoor noise levels. The main rule for both planning and control purposes (control in connection to Environmental Act) are based on the outdoor noise level. In situations where the noise source is in the same building, the indoor levels are used. The new noise indicators L_{den} and L_{night} will not be used for indoor noise limits, i.e. the noise limits for traffic noise will stay as today in terms of $L_{pA,eq,T}$. Any need for harmonization is therefore not present now.

For industrial noise in the same building, the indoor limits in dwellings are given as $L_{pA,eq,T} = 30$ dB (day), 30 dB (evening, weekend) and 25 dB (night). Additionally $L_{pAFmax} = 40$ dB for night time [23]. Noise limits for industrial noise will stay as today in terms of the rating level with 5 dB correction for impulses or tones.

3.3 Iceland

The present Icelandic regulation is based on three different regulations concerning environmental noise. In 1999 a proposal for a new regulation was rejected and currently a review of the regulation is in preparation taking into account EU directive 2002/49 [1]. Major problems with the regulations have been the consideration of outdoor noise from traffic in older neighbourhoods, indoor noise levels from various human activities due to the fact that indoor noise limit values are missing, and that the possibilities for improvement of noise situation have been very limited.

Proposals for new indoor and outdoor limits for environmental noise in Iceland are in preparation. Discussion on how to address indoor noise levels in terms of annual averages of L_{den} and L_{night} , is ongoing. Proposed outdoor traffic noise levels at dwellings are $L_{den} = 55$ dB and $L_{night} = 40$ dB. The corresponding indoor levels are 35 dB and 25 dB. See also Table 1.

The Icelandic building regulations [24] contain limits for indoor and outdoor levels from service equipment only. The sound classification standard IST 45:2003 [11] has also indoor limits for dwellings due to transport sources in accordance with other Nordic countries, i.e. $L_{pAeq24h} = 30$ dB and $L_{pAFmax} = 45$ dB for night time. Structure-borne noise from transport in culverts and tunnels is limited to $L_{pAFmax} = 32$ dB, in the same way as in Denmark and Norway [10, 12].

3.4 Norway

In Norway, the environmental authorities have proposed new noise guidelines for area planning within the scope of Planning and Building Act [2, 3]. The guidelines for area planning contain recommended noise zoning and variable assessment depending on the noise source (transport, shooting, industry, construction works, ports and terminals, motor sport, windmills), i.e. using corrections similar to those based on annoyance in ISO 1996 [4, 5]. Utilization of the noise zones is restricted, e.g. noise sensitive buildings (dwellings, hospitals, schools etc.) in yellow zone ($L_{den} = 55$ to 65 dB) have to be considered in specific for noise insulation and in red zone ($L_{den} < 65$ dB) such new buildings are allowed on certain conditions only. Parks and other areas for recreation are marked as green zones. The zone limits are also given as L_{pAFmax} - or L_{night} -values depending on the type of noise source.

The transfer of $L_{pA,eq,T}$ -values to L_{den} -values has been calculated for some noise situations/ sources [25]. The differences have been found to be at around +3 dB for the road traffic, between +3 and +6 dB for rail traffic, +4 dB for air traffic close to city and typical for Norwegian EFN-values -1 dB. For industry, the typical value is around +2 dB for 5-day week, and +6,4 dB for continuous 24 hour industrial activity. For continuous 24 hour-activity of service equipment $L_{den} = L_{pAeq24h} + 6$ dB.

In addition to transfer of $L_{pA,eq,T}$ -values to L_{den} -values, source annoyance corrections based on the type of source are given in the area planning guidance. These corrections are based on a conservative evaluation and are a compromise. The annoyance corrections are given as follows:

- road traffic 0 dB
- rail traffic -3 dB
- aircraft traffic +3 dB
- industry 0 dB
- regular impulsive industrial noise + 5 dB.

Sound and vibration conditions in Technical regulations [26, 27] require protection of the buildings from noise and vibrations from outdoor sources and from noise originating in the building. The users of the building shall be provided with satisfactory sound and vibration conditions at work, and during sleep, rest and recreation. Noise from service equipment in the building and from various outdoor sources (road, train, sea and air traffic, industry etc.) is included. NS 8175 [12] (at present under revision) may be used for the documentation of fulfilment of these requirements.

NS 8175 contains limit values for both indoor and outdoor noise conditions. The limits may be given as $L_{pA,eq,T}$, L_{pAFmax} - or L_{pCmax} -values. They are valid both for service equipment indoors and outdoors, and for outdoor sources like road, train, sea and air traffic, industry, etc. Transport sources in culverts and tunnels are included in similar way as in Iceland. See also Table 1.

3.5 Sweden

In Sweden, the requirements of the building regulations [28] are considered fulfilled if the limits in class C of SS 025267 [13] are achieved. SS 025267 for dwellings is being revised. SS 026768 [14] defines criteria for other types of buildings and will be revised in a couple of years. Normally, dwellings of class B type are constructed. Class C type dwellings get many noise complaints, which is a new phenomenon. The limits are given as A-weighted equivalent SPLs, $L_{pAeq24h}$, for road traffic. For other outdoor sources, the A-weighted equivalent SPLs are determined for the source operating time. Maximum A-weighted SPLs, $L_{pAF,max}$, for intermittent and regular sounds of short duration may often result in indoor limits that determine what kind of building construction is used. Indoors the given maximum limits may be exceeded at the most 3 times per night (22.00-06.00). In Sweden there is also a long term goal for L_{pAFmax} outdoors. In that case the limit value is 70 dB (including reflection from the façade) which is not to be exceeded more than 5 times any hour during day/evening (06.00-22.00). For quiet areas it is considered to introduce limit values expressed as percent exceedance levels.

Lowest allowable sound insulation of a façade (total of all façade elements) is determined by calculating from 1/3-octave band levels indoors and based on A-weighted SPLs from outdoor sources in such a way that the tabled indoor values of $L_{pAeq24h}$ (22 dB, 37 dB) are not exceeded. This lowest allowable sound insulation is determining for the selection of the building structure. There are no plans for setting indoor limits, using L_{den} -values, neither to use the L_{night} . This is considered to be a political issue.

4. Handling of 24-hour time period

As mentioned earlier, the splitting up of the 24-hours to day, evening and night for outdoor noise mapping purposes is stated in the Directive [1] to be 12 h, 8 h and 4 h. The EU definitions are for daytime 07-19, for

evening 19-23 and for night to 23-07. These are also proposed used in Iceland, Norway and Sweden, while in Finland and Denmark the evening is set to 19-22 and night 22-07. The following matters were stated:

- The time periods to be used was considered as a national matter and not an item for harmonization
- The distribution of the 24-hour period is also practised somewhat differently, see above
- Denmark and Finland have 9 hours night and 3 hours evening period.
- Norway and Sweden have presently the same division of the 24-hour period, i.e. daytime 06 to 18, evening from 18 to 22 and night 22 to 06
- Iceland has today daytime from 07 to 18, evening from 18 to 23 and night from 23 to 07
- The EU Directive allows a deviation of 1 to 2 hours of the evening period from the stated day 07-19, evening 19-23 and night periods 23-07
- The present day-evening-night periods used for industrial noise may differ somewhat from those for other noise sources

The implications of using different time periods when setting noise level limits or guidelines, are not clarified. Definitions of day, evening and night periods may influence both equivalent and maximum indoor noise levels, and it may change the building practise.

Table 1 – Regulations for indoor and outdoor noise conditions in Nordic countries

Country	Noise source	24-hour distribution (day/evening/night/all sources) hours	Outdoor limit (yellow zone-NO) L_{den} (NO) $L_{pA,eqT}$ (SE) dB	Source dependent level correction outdoors/indoors dB	Maximum level outdoors $L_{pAF,max}$ dB	Indoor limit $L_{pA,eqT}$ dB	Maximum level $L_{pAF,max}$ dB
Denmark ¹	Road traffic Rail traffic Air traffic Industry ² Service equipment ³	outdoor/indoor 07-19/07-18 19-22/18-22 22-07/22-07	55 40 ⁴	+5 ⁵	- -	30 30 30/30/25 30	40 (night)
Finland ^{6,7}	Road traffic Rail traffic Air traffic Industry Shooting noise Service equipment	Present/New 07-22 ⁷ /07-19 - /19-22 22-07 ⁷ /22-07	55/50/45 ⁸ 65/60 ⁹ -	+5	-	35/30/25 ¹⁰ 28 ¹¹ 30	33 ¹¹
Iceland ¹²	Road traffic Air traffic Industry Service equipment	07-18 18-23 22-07	55/65 55 50/45/40 45/40/35 ¹³		+5 ¹⁴	45/40/35	40

¹ The present levels. These will not be changed.

² The indoor limits are valid only for noise sources in the same building.

³ The indoor limits for service equipment are valid only for noise sources in the same building.

⁴ In front of windows and on areas for recreation.

⁵ $L_r = L_{Aeq,T} + 5$ dB when impulsive noise and tonality occur. The same limits are set to night, Saturday afternoon and Sunday.

⁶ The indoor levels will not be changed. Indoor limits are given as a level difference between outdoors and indoors.

⁷ Present situation. Only noise mapping limits are changed. No changes in other regulations. No changes at indoor levels. 24-hour-distribution is changed for noise mapping purposes

⁸ New dwellings at night time. Planning/environmental guidelines 07-22 and 22-07. For impulsive noise and narrow band noise +5 dB is added to the measurement result.

⁹ $L_{A1,max}$

¹⁰ In guidelines for health authorities, the following is stated: equivalent level 35 dB day/30 dB night/25 dB music at night 22-02. In secondary rooms, 5 dB higher levels are allowed. In addition, there are recommended limits in 1/3 octave bands for frequency range 20-200 Hz for night time. In planning/environmental guidelines the levels are 35 dB /30 dB.

¹¹ Limits in building regulations. 5 dB higher levels are allowed in secondary rooms. 10 dB higher levels are allowed when air velocity may be increased only in an owners dwelling/flat.

¹² New regulations are in preparation. Use of L_{den} and L_{night} are in consideration.

¹³ Recommended limits in the building code for at least one outdoor area for each dwelling (flat).

¹⁴ $L_r = L_{Aeq,T}$ when impulsive noise and tonality occur. The same limits are set to evening and weekends.

Country	Noise source	24-hour distribution (day/evening/night/all sources) hours	Outdoor limit (yellow zone-NO) L_{den} (NO) $L_{pA,eqT}$ (SE) dB	Source dependent level correction outdoors/indoors dB	Maximum level outdoors $L_{pAF,max}$ dB	Indoor limit $L_{pA,eqT}$ dB	Maximum level $L_{pAF,max}$ dB
Norway ¹	Road traffic Rail traffic Air traffic Industry Industry, imp. Harbour/terminal Motor sport Shooting Windmills Construction works Service equipment	outdoor/indoor 07-19/06-22 19-23/18-22 23-07/22-06	55 58 52 55 50 50 50 30 44 65/55/50 (50/45/40) ²	0/- -3/- +3/- 0/- +5/+5	70 75 80 45 ³ /60 45 ³ /60 45 ³ /60 limited activity 50 ⁴ - 45/40/35	30 (total level, all sources) 40/35/30 30	45 (night) 32 ⁵
Sweden ⁶	Road traffic Rail traffic Air traffic Industry Low frequency noise Service equipment	Present 6-18 18-22 22-06	55 ⁷ (60) (general level)		70 ⁷	B/C 26/30 ⁷ 30 ⁸ (general level) 100 ⁹	B/C 41/45 ⁸ (night) 35-45 ⁹ 115 ⁹

¹ The outdoor limits are the proposed new noise guidelines for land use plans. The indoor limits are the present ones given in NS 8175, except for construction works.

² State noise pollution control. For industrial concessions, there are no separate limits for service equipment or similar.

³ L_{night}

⁴ L_{pAImax}

⁵ The same limit applies also for noise from transport sources in culverts and tunnels

⁶ The present levels. These will not be changed.

⁷ Outdoor limits are given by Swedish Environmental Protection Agency. Limits apply at the facade. Maximum level for aircraft noise is given as FBN-values.

⁸ Building regulations. May be exceeded with three events per night (changed since 2002 when the number of events was 5 times). Many class B buildings are built today. $L_r = L_{Aeq,T} + 5$ dB when impulsive noise and tonality occur.

⁹ Limits given by The National Board of Health and Welfare in Sweden. In addition, equivalent level limits are given for low frequency noise in 1/3-octave bands in the frequency range 31,5–200Hz.

5. Maximum sound pressure level, $L_{pAF,max}$, and night time equivalent level, L_{night}

Application of the new indicator L_{night} and the present A-weighted maximum SPL, $L_{pAF,max}$, was discussed. Limits, using the latter, are today given in Iceland, Norway and Sweden. In Denmark and Finland, limits are only given for equivalent levels, $L_{pA,eq,T}$, and application of L_{night} -values are under consideration.

The DP INSTA 122 and the national classification standards such as draft NS 8175:2004 (in preparation) use a limit $L_{pA,max} = 45$ dB for indoor noise level from outdoor sources, if more than 10 events exceed the level at night (i.e. during hours 22 to 06). As an example, the Norwegian proposal for area use planning for noisy environments [2] applies $L_{pA,max} = 70$ dB for outdoor free field conditions. For road traffic in the zone for noise assessment (yellow zone), the criteria concern more than 10 events exceeding the level limit at night time, i.e. between hours 23 and 07, similar for rail traffic, 75 dB, and for aircraft traffic, 80 dB. Comparisons of indicators $L_{pAF,max}$ and L_{night} for certain traffic situations show that traffic volumes giving 10 noisy events at night may often result in $L_{night} \geq 30$ dB.

At situations where the noise level is low, the distance to the source is short, the vehicle velocity is high and there is a high percentage of heavy vehicles, a very low traffic volume may generate 10 noisy events above 45 dB indoors or above 70 dB outdoors. Also light-weight vehicles may generate noisy events above the level 45 dB in a similar situation. Then $L_{pA,eq24h} = 30$ dB and $L_{den} = 55$ dB may be sufficient criteria also for night time protection.

For rail traffic, at places with few pass-bys the number of events may be below 10, but due to the length of the trains there may be several noisy peaks exceeding the limits and disturbing the sleep of nearby inhabitants. Consideration of the length of pass-bys is therefore necessary, and it was questioned whether $L_{pAF,max} \geq 45$ dB and $N > 10$ is a relevant set of descriptors for considering the sleep disturbance due to various sources for noisy events at night time (light road vehicles and freight trains).

The following conclusions and recommendations were found:

- It was agreed that $L_{pA,max}$ has to be carefully defined before being used for regulation purposes. Unclear definitions may cause unintended consequences, and the uncertainty in the determination may be high. The maximum levels have, as a minimum, to be connected to the number and possibly to the duration of the noise events.
- Long-lasting single noise events (e.g. long trains) that exceed the maximum level limits are problematic. How should the maximum level be defined? In such cases the night equivalent level could give a more correct indicator for the noise situation.
- Limits on maximum level from service equipment should differ from those for other noise sources (transport, industry and similar). Maximum levels may be used for service equipment.

6. Indoor noise levels in Nordic countries - Future plans

As mentioned in section 3, the noise conditions are regulated in somewhat different ways in the Nordic countries, and by different authorities at health, building and environmental departments. Transfer of present A-weighted continuous equivalent sound pressure levels, $L_{Aeq,T}$, to day-evening-night levels, L_{den} , for different sources are described in research reports from Denmark, Finland, Norway and Sweden [ref. 9, 15, 25, 29]. The results are similar.

Plans for using the new noise indicators, L_{den} and L_{night} , are as following:

- L_{den} and L_{night} are considered for the time being for noise mapping purposes in all Nordic countries.
- Denmark, Finland and Sweden do not plan to shift to L_{den} in noise regulations, except for noise mapping as given in the EU Directive
- Norway has revised the noise guidelines for area use planning within the scope of the Planning and Building Act and noise zones with noise limits given as L_{den} -values outdoors
- Iceland is planning to give new guidelines for outdoor noise, and the contents are under discussion.
- None of the Nordic countries plan to change the indoor levels at this stage. The authorities await the situation. Changing of the limits may be actualized in 2007.
- In Norway, source dependent corrections for outdoor noise, based on annoyance, are implemented in a new guideline for area planning. Such corrections are not presently used by the other Nordic countries.

7. Conclusions, suggestions and recommendations

Specification of the noise conditions in the European countries differs from those in Nordic countries. Limits given as indoor noise levels are unknown in Southern Europe. It is therefore important to discuss the Nordic way of specifying the indoor noise limits and conditions compared to the European ones, especially due to the harmonization plans in EU [1].

No harmonization of indoor A-weighted equivalent SPLs, $L_{pA,eq,T}$, with the outdoor noise mapping with limits in L_{den} , are planned at this stage. It is necessary to collect experience from noise mapping and use the knowledge in the future assessments. Reconsideration of the indoor and outdoor limits is expected to come up at around year 2007 when EU plans come to the second phase. Practical guidance on transfer between $L_{pA,eq,T}$ and L_{den} -values for indoor noise situation and consequences for the façade building constructions should be prepared for area planning work, for comparison with the present limit values etc. Studies and research on transfer between indoor and outdoor noise conditions by using the new and present indicators are therefore essential. This is

necessary for deciding on how to express the indoor noise conditions by means of the new indicators and how to determine the transfer functions.

Common Nordic harmonization concerning defining the day, evening and night periods, is not planned. This was considered to be a national matter. The Nordic countries specify the 24 hour-period within the time limits allowed by the EU Directive [1]. Consequences of changes/ differences in day-evening-night hours need to be studied, especially when the night time maximum noise levels and the evening period are considered.

There are many pitfalls when using limits given as maximum sound pressure levels, $L_{pA,max}$. If maximum levels are used alone as limits for the night time noise exposure, at least the number and possibly the duration of the noise events should be specified. Limits formulated using a combination of the maximum level, $L_{pAF,max}$, and the night time equivalent level, L_{night} , may be more appropriate. Systematic examination of present knowledge and experience of noise exposure patterns of the various noise sources, combined with new research, are needed in order to have a sufficient basis for stating satisfactory limits for night time maximum and equivalent sound pressure levels.

Discussions on noise and sound insulation regulations crosswise at the Nordic level on current matters were found to be most useful and constructive. There was a common agreement on that this should be a yearly or more frequent occurrence. Relevant authorities (environmental, building and health) and acoustical experts should be involved in discussions.

8. References

- [1] 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.
- [2] T-9999 Retningslinjer for arealbruk i støyutsatte områder. Miljøverndepartementet. Høringsutgave, Januar 2004. Norway.
- [3] Forskrift om støy. Kartlegging, handlingsplaner og tiltaksgrenser for eksisterende virksomhet. Miljøverndepartementet, 2003. Norway.
- [4] ISO 1996-1 Acoustics - Description, measurement and assessment of environmental noise - Part 1: Basic quantities and assessment procedures. ISO, 2003.
- [5] ISO 1996-2 Acoustics - Description, assessment and measurement of environmental noise - Part 2: Determination of environmental noise levels. ISO, 2003.
- [6] O. F. Vaage. Til alle døgnets tider. Tidsbruk 1971-2000, Statistisk Sentralbyrå, SSB, april 2002. ISBN 82 537 5055-2, trykt versjon. ISBN 82 537 5059-5, electronic version. Norway.
- [7] Retningslinjer for bygningsbestemmelser vedrørende lydforhold. NKB-rapport nr. 32. Nordic Committee for Building regulations, Maj 1978.
- [8] Lydbestemmelser i de nordiske lande. NBK Utskotts- och arbets rapporter, 1994:01. ISBN 951-47-9488-5. Helsingfors 1994.
- [9] DP INSTA 122:1997 Sound classification of dwellings.
- [10] DS 490 Lydklassifikation af boliger (Sound classification of dwellings). Dansk Standard, 2001. (In Danish)
- [11] ÍST 45:2003 Hljóðvist - Flokkun íbúðarhúsnæðis. (= INSTA 122, in English)
- [12] NS 8175 Lydforhold i bygninger. Lydklasser for ulike bygningstyper. (Acoustic conditions in buildings - Classification of various types of buildings). NSF, 1997. (Under revision in 2004, in Norwegian)
- [13] SS 025267:1998 Byggakustik - Ljudklassning av utrymmen i byggnader - Bostäder and T1 - Tillägg 1: Rättelser (Acoustics - Sound classification of spaces in buildings - Dwellings & Amd 1: Corrections) (In Swedish)
- [14] SS 025268:2001 Byggakustik - Ljudklassning av utrymmen i byggnader - Vårdlokaler, undervisningslokaler, dag- och fritidshem, kontor och hotel (Acoustics - Sound classification of spaces in buildings - Institutional premises, rooms for education, preschools and leisure-time centres, rooms for office work and hotels). (In Swedish)
- [15] Effects of directive 2002/49/EC on the methods now used in Finland to assess environmental noise (Ympäristömeludirektiivin vaikutukset melun arviointimenetelmiin). The Finnish Environment 610. March 2003. Ministry of the Environment/VTT. ISBN 952-11-1342-1. (in Finnish)
- [16] Amendment of the Environmental Protection Act. RP 170/2003 rd. Finland
- [17] Nationellt genomförande i Finland av bullerdirektivet 2002/49/EG. Promemoria 24.10.2002. Miljöministeriet. Finland.
- [18] The National Building Code of Finland. C Insulation; C1 Sound insulation and noise abatement in building - Regulations and guidelines. Ministry of the Environment. Electronic reference: <http://www.environment.fi/default.asp?contentid=75666&clan=SV>
- [19] Sound insulation requirements for building facades. Ympäristöopas 108, Ministry of the Environment of Finland, 2003.

- [20] Proposal for announcement on mapping of external noise. The Danish Agency on Environmental Protection, 26 March 2004. Denmark.
- [21] Ændring i støjniveauer ved skift fra den eksisterende støjindikator for vejtrafikstøj og støj fra jernbaner til EU-støjindikatoren Lden. DELTA Rapport AVC 1579/03. Miljøstyrelsen 2003. Denmark.
- [22] BR-95. Bygningsreglement 1995, Bygge- og Boligstyrelsen. Denmark
- [23] Ekstern støj fra virksomheder. Vejledning 5/1984. Miljøstyrelsen. Denmark
- [24] Isländska byggnormen. Iceland
- [25] Nye måleenheter for støy i EUs rammedirektiv. Konsekvensanalyser. SINTEF Rapport. SFT40 A03027. ISBN 82-14-03092-7. Norway.
- [26] Plan- og bygningslov. LOV 1985-06-14 nr 77 med senere endringer. ISBN 82-504-1434-9. Miljøverndepartementet. Norway.
- [27] Forskrift om krav til byggverk og produkter til byggverk. Tekniske forskrifter til plan- og bygningsloven av 14. juni 1985 nr. 77. Fastsatt 22. januar 1997 nr. 33. Ajourført med endringer, senest ved forskrift 29. august 2001 nr. 1069. Kommunal- og regionaldepartementet. Norway.
- [28] Building regulations BFS 2002:19 i bostäder. Sweden.
- [29] Konsekvenser av övergang från dygnsmedelvärdet till dag/kväll/nattvägda årsmedelvärdet för vägtrafikbuller. SP Rapport 2001:08. Akustik. Borås 2001. Sweden.