BNAM2012
Joint Baltic-Nordic Acoustics Meeting
June 18th - 20th 2012 Odense, Denmark

Sound classification of dwellings in the Nordic countries – Differences and similarities between the five national schemes

Birgit Rasmussen
SBi, Danish Building Research Institute, Aalborg University, DK-2970 Hørsholm, Denmark, bir@sbi.aau.dk

In all five Nordic countries, sound classification schemes for dwellings have been published in national standards being implemented and revised gradually since the late 1990s. The national classification criteria for dwellings originate from a common Nordic INSTA-B proposal from the 1990s, thus having several similarities.
In 2012, status is that number and denotations of classes for dwellings are identical in the Nordic countries, but the structures of the standards and several details are quite different. Also the issues dealt with are different. Examples of differences are sound insulation internally in dwellings, classification of outdoor areas and verification of compliance with a specific quality class. Furthermore, classification of other types of buildings like schools and offices has been included in Norway, Finland and Iceland, but not in Denmark, and Sweden has a separate standard for classification of such buildings.
This paper presents and compares the main class criteria for sound insulation of dwellings and summarizes differences and similarities in criteria and in structures of standards.
Classification schemes for dwellings also exist in several other countries in Europe and with an even higher diversity, impeding exchange of experience about constructions and creating trade barriers like in the Nordic countries.

1 Introduction

National schemes for sound classification of dwellings exist in all five Nordic countries, cf. [1, 2, 3, 4, 5]. Some of the schemes include classification criteria for other types of buildings than housing. The class criteria for dwellings originate from a common Nordic INSTA-B proposal from the 1990s, cf. latest draft [6], thus having several similarities, but also many differences due to the development in national standardization committees, after the Nordic coordination stopped. The classification schemes are published in national standards. The class criteria relate – like the building regulations – to airborne and impact sound insulation, noise levels from traffic and technical installations as well as other acoustical and noise aspects. This paper focuses on sound insulation between dwellings and of facades.

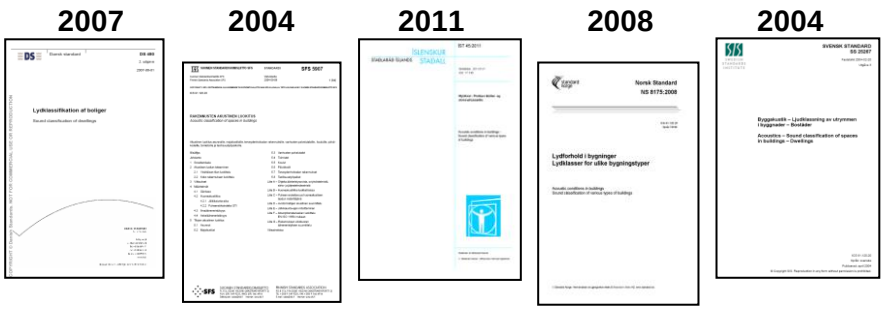

Figure 1: Nordic countries. Sound classification of dwellings, status March 2012 for classification schemes published by national standardization organizations.

2 Sound classification of dwellings – Overview schemes in the Nordic countries

An overview of sound classification schemes for dwellings in the Nordic countries is found in Table I, which includes information about class denotations and publication year for editions of classification standards since the first versions. Moreover, for each sound classification scheme listed in Table I, the relation to the national building code is indicated as well as the classes intended for new housing and for existing housing, i.e. old/renovated and other not new housing.

Table I. Nordic schemes for sound classification of dwellings, relation to building codes and indication of classes intended for new and "old" dwellings. Status March 2012.

Coun-try	Class denotations (1)	Year of publication	CS Reference (latest version)		BC	Link BC to CS	BC Reference to CS	Classes for new buildings	Classes for "old" buildings
DK	A / B / C / D	2001/2007	DS 490 (2007)	[1]	2010 [7]	+	Class C	A, B, C	D
FI	A / B / C / D	2004	SFS 5907 (2004)	[2]	1998 [8]	–	None (2)	A, B, C	D
IS	A / B / C / D	2003/2011	IST 45 (2011)	[3]	2012 [9]	+	Class C	A, B, C	D
NO	A / B / C / D	1997/2005/2008	NS 8175 (2008)	[4]	2010 [10]	+	Class C	A, B, C	D
SE	A / B / C / D	1996/1998/2004	SS 25267 (2004)	[5]	2012 [11]	+	Class C	A, B, C	D

Abbreviations: BC = Building Code (regulatory requirements); CS = Classification scheme
(1) Classes are indicated in descending order, i.e. the best class first.
(2) Building regulations specify the same limits as in Class C

Classification schemes also exist in several other countries in Europe. For information, see [12, 13]. Details about facade sound insulation class criteria are found in [14], and updated information for the Nordic countries in Section 4 (this paper). Details about class criteria for sound insulation internally in dwellings are found in [15]. Aspects related to sound classes for renovated housing are described in [16].

The status of the classification schemes in relation to the regulatory requirements varies, cf. Table I for Nordic countries and [12, 13] for other countries in Europe. In some countries there is no link between the building code and the classification scheme. In other countries they are strongly "integrated", and the building code refers to a specific class in the classification standard rather than describing the requirements. The regulatory main requirements for airborne and impact sound insulation between dwellings in 24 European countries are presented in [17, 18]. Some updates and extension to more countries are found in [19].

Sound insulation requirements and class criteria are expressed by descriptors defined in standards. Within building acoustics, ISO standards are implemented as European (EN) standards and national standards The current international descriptors for evaluation of airborne and impact sound insulation are defined in ISO 717:1996 [20]. The single-number quantities and the spectrum adaptation terms are derived from values measured according to ISO 140 [21]. For some types of buildings, e.g. for light-weight buildings, it is important to include low-frequency spectrum adaptation terms (down to 50 Hz), cf. e.g. references in [17, 18], or other criteria taking into account low frequencies to obtain a significantly improved correlation between subjective and objective sound insulation.

The sound classification schemes in the Nordic countries are based on a common Nordic draft proposal from INSTA-B, see [6], but due to asynchronous revision of building regulations in the Nordic countries, the national schemes were finished and published at different times and since then revised in four of 5 countries, see Table I.

The INSTA-B proposal included dwellings only. Classification of other types of premises, e.g. schools, kindergarten, offices, hotels has also been implemented in Finland, Iceland, Norway and Sweden, cf. Table VI in Section 5, but the present paper focuses on dwellings only.

In Section 3 the main class criteria for airborne and impact sound insulation between dwellings are described. Class criteria related to facade sound insulation are found in Section 4. Apart from traffic noise limits related to facade sound insulation, noise limits are not dealt with in this paper.

3 Sound insulation between dwellings – Class criteria in Nordic schemes

The main criteria for airborne and impact sound insulation between dwellings are found in Tables II and III. The classification schemes also include many other sound insulation criteria, e.g. from stairways and noisy premises to dwellings.

Table II. Airborne sound insulation between dwellings.
Main criteria in sound classification schemes in the Nordic countries.

Airborne sound insulation between dwellings - Main class criteria in dB **Status March 2012**						
Country	**Class A**	**Class B**	**Class C**	**Class D**	**Comments**	**BC reference to CS**
DK [1]	$R'_w + C_{50-3150} \geq 63$	$R'_w + C_{50-3150} \geq 58$	$R'_w \geq 55$	$R'_w \geq 50$		Class C
FI [2]	$R'_w + C_{50-3150} \geq 63$	$R'_w + C_{50-3150} \geq 58$	$R'_w \geq 55$	$R'_w \geq 49$		None (BC = Class C)
IS [3]	$R'_w + C_{50-3150} \geq 63$	$R'_w + C_{50-3150} \geq 58$	$R'_w \geq 55$ (1)	$R'_w \geq 50$		Class C
NO [4]	$R'_w + C_{50-5000} \geq 63$	$R'_w + C_{50-5000} \geq 58$	$R'_w \geq 55$ (1)	$R'_w \geq 50$		Class C
SE [5]	$R'_w + C_{50-3150} \geq 61$	$R'_w + C_{50-3150} \geq 57$	$R'_w + C_{50-3150} \geq 53$	$R'_w \geq 49$	Volume limitations apply, cf. [5], 3.1.	Class C
(1) Use of $C_{50-3150/5000}$ is recommended also in Class C. If applied, the limit values may be reduced by 2 dB						

Table III. Impact sound insulation between dwellings.
Main criteria in sound classification schemes in the Nordic countries.

Impact sound insulation between dwellings - Main class criteria in dB **Status March 2012**						
Country	**Class A**	**Class B**	**Class C**	**Class D**	**Comments**	**BC reference to CS**
DK [1]	$L'_{n,w} \leq 43$ and $L'_{n,w} + C_{I,50-2500} \leq 43$	$L'_{n,w} \leq 48$ and $L'_{n,w} + C_{I,50-2500} \leq 48$	$L'_{n,w} \leq 53$	$L'_{n,w} \leq 58$		Class C
FI [2]	$L'_{n,w} \leq 43$ and $L'_{n,w} + C_{I,50-2500} \leq 43$	$L'_{n,w} \leq 49$ and $L'_{n,w} + C_{I,50-2500} \leq 49$	$L'_{n,w} \leq 53$ (1)	$L'_{n,w} \leq 63$		None (BC = Class C)
IS [3]	$L'_{n,w} \leq 43$ and $L'_{n,w} + C_{I,50-2500} \leq 43$	$L'_{n,w} \leq 48$ and $L'_{n,w} + C_{I,50-2500} \leq 48$	$L'_{n,w} \leq 53$ (1)	$L'_{n,w} \leq 58$		Class C
NO [4]	$L'_{n,w} \leq 43$ and $L'_{n,w} + C_{I,50-2500} \leq 43$	$L'_{n,w} \leq 48$ and $L'_{n,w} + C_{I,50-2500} \leq 48$	$L'_{n,w} \leq 53$ (1)	$L'_{n,w} \leq 58$	Volume limitations apply, cf. [4], 4.2.	Class C
SE [5]	$L'_{n,w} \leq 48$ and $L'_{n,w} + C_{I,50-2500} \leq 48$	$L'_{n,w} \leq 52$ and $L'_{n,w} + C_{I,50-2500} \leq 52$	$L'_{n,w} \leq 56$ $L'_{n,w} + C_{I,50-2500} \leq 56$	$L'_{n,w} \leq 60$	Volume limitations apply, cf. [5], 3.2.	Class C
(1) Use of $C_{I,50-2500}$ is recommended also in Class C.						

Concerning the airborne sound insulation class criteria in Table II, the main difference between the five Nordic countries is that Sweden applies a low-frequency descriptor in Class C, which is also the regulatory requirement, and has in all classes 1-2 dB lower limits than the other countries. Volume limitations apply for Sweden, see Table I.

Considering impact sound insulation class criteria in Table III, there are more differences. The criteria for DK, IS, NO are almost identical in all classes. FI allows 5 dB higher impact level in class D, otherwise also almost identical. On the contrary, Sweden has 4 - 5 dB weaker criteria in classes A and B. In class C, a low-frequency descriptor is applied, but a 3 dB weaker number. In general, the Swedish impact sound insulation requirements are weaker, but the real difference to the other Nordic countries depends on construction types. Volume limitations apply for Norway and Sweden, see Table II.

If comparing with class criteria in other countries in Europe, cf. [12, 13], it is obvious that the sound insulation class limits and other features in the Nordic countries are much more identical than observed from a wider comparison with other classification schemes in Europe. Among other things, descriptors, range of quality levels, number of quality classes, class intervals and denotations vary across Europe.

In Figures 2 and 3 are found graphical comparisons of lowest and best classes in the Nordic countries and six other European countries (LT, IT, DE, AT, NL, FR). The regulatory requirements in the same countries have been added. Data are from [13, 19], and more information is found in the same references.

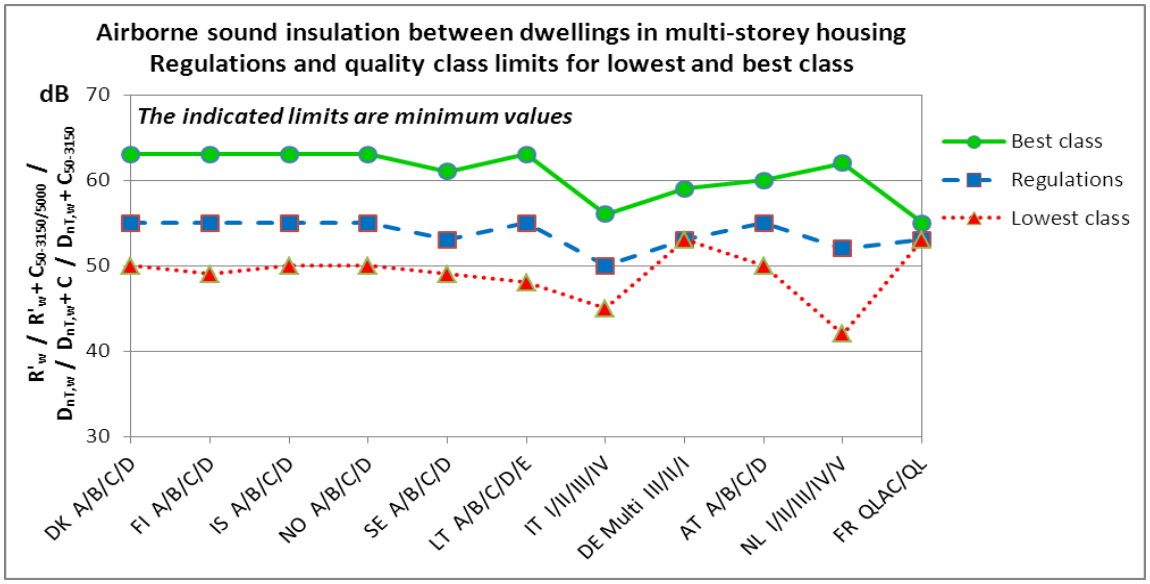

Figure 2: Airborne sound insulation limits for highest and lowest classes in 11 classification schemes in Europe and regulatory requirements for the same countries. Data are from [13, 19].
Note: The graphs present the numbers only. No conversions between descriptors have been applied.

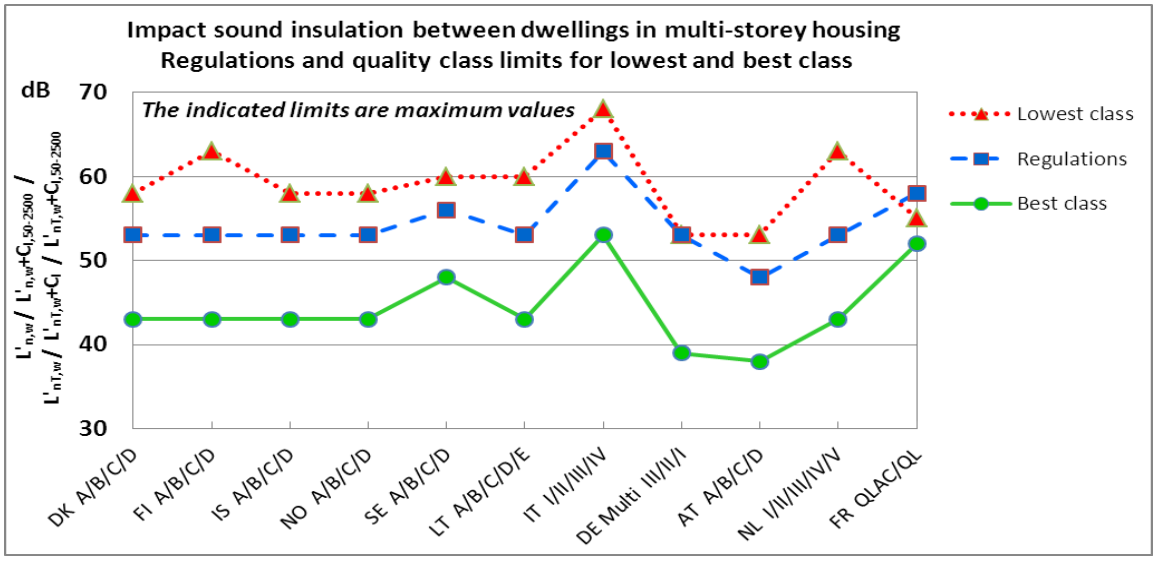

Figure 3: Impact sound insulation limits for highest and lowest classes in 11 classification schemes in Europe and regulatory requirements for the same countries. Data are from [13, 19].
Note: The graphs present the numbers only. No conversions between descriptors have been applied.

Qualitative descriptions of sound classes are useful for communication purposes and for making a qualified choice of class. Thus, verbal descriptions and other information are important. As an example, summarized information based on descriptions in DS 490 is found in Table IV - similar to descriptions in the INSTA-B proposal [6]. Another way to characterize sound classes is to indicate typical neighbour noises like speech (normal, raised, loud), walking, installations, music, television, parties, and for each type of noise describe the perception corresponding to the different sound classes. Examples are found in [22].

Table IV: Occupants' expected satisfaction for different sound classes according to DS 490:2007 [1]. Summary based on information in DS 490.

Sound insulation between dwellings Main class criteria in DS 490:2007		
Class	**Airborne**	**Impact**
A	$R'_w + C_{50\text{-}3150} \geq 63$ dB	$L'_{n,w} \leq 43$ dB and $L'_{n,w} + C_{I,50\text{-}2500} \leq 43$ dB
B	$R'_w + C_{50\text{-}3150} \geq 58$ dB	$L'_{n,w} \leq 48$ dB and $L'_{n,w} + C_{I,50\text{-}2500} \leq 48$ dB
C	$R'_w \geq 55$ dB	$L'_{n,w} \leq 53$ dB
D	$R'_w \geq 50$ dB	$L'_{n,w} \leq 58$ dB
Reference: DS 490:2007, "Lydklassifikation af boliger" (Sound classification of dwellings).		

Characteristics of DS 490 sound classes for dwellings and occupants' expected evaluation Information compiled based on DS 490		
Sound class descriptions	**Good or very good**	**Poor**
Excellent acoustic conditions. Occupants will be disturbed only occasionally by sound or noise.	**> 90 %**	
Significant improvement compared to minimum in class C. Occupants may be disturbed sometimes.	**70 to 85 %**	**< 10 %**
Sound class intended as the minimum for new buildings.	**50 to 65 %**	**< 20 %**
Sound class intended for older buildings with less satisfactory acoustic conditions, e.g. for renovated dwellings.	**30 to 45 %**	**25 to 40 %**
Note: Within each sound class the percentage of satisfied or dissatisfied occupants may depend on the type of criterion. The grouping is mainly based on the subjective assessments of airborne and impact sound from adjacent dwellings.		

4 Facade sound insulation i dwellings – Class criteria in Nordic schemes

In the Nordic countries, the classification schemes define limits for indoor traffic noise levels dependant on room type. Limits for living rooms are found in Table V. None of the Nordic countries have identical criteria, although they are almost the same in IS and NO with IS being closest to INSTA-B [6]. The most noticeable contrast between the five countries is the different descriptors applied for noise limits during night. IS, NO, SE apply event-based limits like in the INSTA-B proposal [6], while DK and FI use equivalent noise levels.

Table V: Nordic schemes for sound classification of dwellings. – Criteria related to facade sound insulation.

Nordic schemes - Main class criteria for traffic noise levels in living rooms – March 2012								
Country with indication of reference		**Required performance for quality levels** (1), [dB]						**Comments**
		Descriptor	**Class A**	**Class B**	**Class C**	**Class D**	**Details**	
DK	[1]	$L_{Aeq,24h}$ (indoor)	≤ 20	≤ 25	≤ 30	≤ 35	[1] Table 5a	For classification, either Table 5a or 5b can be used. Sum of all traffic sources. For regulations, see note (3).
		L_{den} (indoor)	≤ 23	≤ 28	≤ 33	≤ 38	[1] Table 5b	
		L_{night} (indoor)	≤ 15	≤ 20	≤ 25	≤ 30	Night 22-07	
FI	[2]	$L_{Aeq,\ 07\text{-}22}$ (indoor)	≤ 25	≤ 30	≤ 35	≤ 35		5 dB higher limits apply for kitchen
		$L_{Aeq,\ 22\text{-}07}$ (indoor)	≤ 20	≤ 25	≤ 30	≤ 30		
IS	[3]	$L_{p,Aeq,24h}$ (indoor)	≤ 20	≤ 25	≤ 30	≤ 35		5 dB higher limits apply for kitchen
		$L_{p,Amax,\ 23\text{-}07}$ (indoor)	≤ 35	≤ 40	≤ 45	None	See note (2)	
NO	[4]	$L_{p,Aeq24h}$ (indoor)	≤ 20	≤ 25	≤ 30	≤ 35		Limits for $L_{p,AFmax}$ apply to sleeping rooms only.
		$L_{p,AFmax,\ 23\text{-}07}$ (indoor)	≤ 35	≤ 40	≤ 45	≤ 50	See note (2)	
SE	[5]	$L_{pAeq,24h}$ (indoor)	≤ 22	≤ 26	≤ 30	≤ 34		Higher limits apply for kitchen
		$L_{pAFmax,\ 22\text{-}06}$ (indoor)	≤ 37	≤ 41	≤ 45	≤ 49	See note (2)	

Notes

(1) The full sets of criteria and definitions are found in the references.
(2) IS and NO: ≥ 10 events, not single events; SE: Not exceeded more than 3 times per avg. night.
(3) DK: Day 07-19 (default), Evening 19-22, Night 22-07. L_{den} and L_{night} defined in END (2002), see [23]. The Danish Building Code refers to L_{den} as the only limit and valid for roads and railways separately.

It is worth mentioning that the class limits related to facade sound insulation are expressed as indoor noise limits, not as sound insulation using ISO 717 descriptors [20] – unlike facade class criteria and building regulations in other countries in Europe, where the minimum facade sound insulation is a function of the outdoor traffic noise level, cf. e.g. [14].

5 Differences and similarities between the five national schemes

A comparison between the Nordic countries of main class criteria for airborne and impact sound insulation between dwellings, cf. Section 3, and for facade sound insulation criteria, cf. Section 4, reveals that there are several differences. However, in a European perspective, the similarities are obvious and the differences seem to be minor. Nevertheless, there are other differences worthwhile mentioning.

In Table VI is found a list of sound classification standards in the Nordic countries with building types indicated for each of the standards and with notes about the main structure of the standards. It is seen that DK is the only country with classification of dwellings only, and that the structures of the standards are very different. It should be added that there are many more differences than appearing in the table, and of course the criteria also vary. – Most other classification schemes in Europe do only deal with dwellings, but a few include other types of buildings, e.g. Lithuania and Italy.

In Table VII are shown examples of differences in issues dealt with for dwellings. In INSTA-B [6], class criteria for both sound insulation internally in dwellings and traffic noise levels at outdoor areas were included, and IS, NO, SE have chosen to do the same. DK includes none of these issues and FI only internal sound insulation in dwellings.

Table VI: Building types in the sound classification schemes in the Nordic countries.

Country	Classification scheme (CS)		Dwellings	Schools	Kinder-garten	Healthcare facilities	Offices	Other	No. of pages
"INSTA-B"	DP INSTA 122	[6]	+	–	–	–	–	–	12 pp
DK	DS 490:2007	[1]	+	–	–	–	–	–	12 pp
FI	SFS 5907:2004	[2]	+	+	+	+	+	+	34 pp
IS	IST 45:2011	[3]	+	+	+	+	+	+	37 pp
NO	NS 8175:2008	[4]	+	+	+	+	+	+	41 pp
SE	SS 25267:2004	[5]	+	–	–	–	–	–	48 pp
	SS 25268:2007	[24]	–	+	+	+	+	+	39 pp

Notes about structure of standards

- DK: Structured according to performance area.
- FI, IS, NO: Main structure according to building type, i.e. dwellings, schools, offices etc. in separate Sections. Substructure: performance area (airborne, impact etc.)
- SE: SS 25267 structured according to classes, first class A with all performance criteria, then class B etc. and SS 25268 structured according to performance area, substructure according to building type.

Table VII: Sound classification of dwellings in the Nordic countries.
Overview of schemes and examples of differences in issues dealt with.

Country	Classification scheme (CS)		Sound insulation internally in dwellings	Traffic noise outdoor areas
"INSTA-B"	DP INSTA 122	[6]	Class A, B	+
DK	DS 490:2007	[1]	–	–
FI	SFS 5907:2004	[2]	Class A, B	–
IS	IST 45:2011	[3]	Class A, B	+
NO	NS 8175:2008	[4]	Class A, B	+
SE	SS 25267:2004	[5]	Class A, B	+

In 2010, comparisons of sound insulation descriptors and requirements applied for dwellings in the Nordic countries were made and the findings published in [25] and [26]. It was found that descriptors and other rules differ more than what is obvious at the first glance. Some differences were found in the classification schemes, e.g. use of "standardized" descriptors instead of "normalized" above certain volume limits, other special rules were found in other publications.

It was found that there is a lot more to do until the differences between the sound insulation requirements and the classification schemes in the Nordic countries are fully described and that it would be of great benefit to sort out unnecessary additional rules and keep special rules to a minimum. Nordic countries were rather close to meet an agreement in the 1990es, and there was a tradition for cooperation about acoustic regulations in NKB, see e.g. [27]. However, lack of consensus and the asynchronous revisions of building regulations led to stop of coordination soon after, and differences between the Nordic countries have increased since then. When analyzing and comparing the

diversified requirements and classification standards existing now, more than 15 years later, it seems to be time to reconsider the situation and reopen cooperation to the benefit of the residents of dwellings, building industry and development of building constructions. The present situation impedes development and creates trade barriers, and there seems to be a high interest in changing the situation. In [25], [26], it was concluded that a revived Nordic cooperation could contribute to identify the most important main differences in descriptors, limits and special rules, and it was proposed to prepare a common Nordic document with an overview of all national building acoustic requirements and classes in the Nordic countries, starting with dwellings. The present paper is hopefully a step on the road to a closer Nordic cooperation.

6 Conclusions and perspectives for reviving the Nordic cooperation

More than ten countries in Europe have implemented sound classification schemes for dwellings. The diversity in and between the various national schemes are described in [12] and [13], and a more detailed comparison of the schemes in the five Nordic countries is found in this paper. When comparing all schemes in Europe, significant discrepancies are found between descriptors, number of quality classes, class ranges, class intervals, and class levels vary. The most striking differences between countries are found in impact sound insulation criteria.

Even in the Nordic countries, the classification schemes have diversified, although a common Nordic proposal existed in the 1990s. In a European perspective, there are many similarities between the schemes in the Nordic countries, and the differences could seem to be minor. Nevertheless, when studying all details, there are numerous differences impeding trade and benefits of exchange of data and experience. It is concluded that a revived Nordic cooperation could prove useful. Regional efforts to exchange experience, develop constructions and methods and harmonize requirements are made in more national and transnational projects, e.g. in Silent Spaces [28] aiming at reducing noise and vibrations in buildings and dwellings, especially light-weight buildings, and contribute to harmonization of requirements in Sweden and Denmark.

At the same time, it is important to support and influence cooperation in Europe, among other things due to harmonized EN standards and for trade reasons. During the last two years, there has been an active Nordic participation in the European Action, COST TU0901 "Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing Constructions" [29], established in 2009 and running until 2013. The purpose is to initiate harmonization and coordinate research. The TU0901 main objectives are:

- Propose harmonized descriptors for airborne and impact sound insulation.
- Propose a European acoustic classification scheme for dwellings.

Previous studies [18, 19] and the development in Nordic countries, see references in [25, 26], seem to indicate that instead of the present R'_w and $L'_{n,w}$ as the basic descriptors for airborne and impact sound insulation limits in the Nordic countries, the preferred descriptors could be $D'_{nT,w}$ and $L'_{nT,w}$ combined with low-frequency adaptation terms. In a revived Nordic cooperation, a close cooperation with the Baltic countries should be established, because their regulations to a wide extent are inspired by the Nordic countries. The results of a revived Nordic cooperation could support the revision of ISO 717 [20] and the ISO 140 field standards [21] as well as national and regional projects and cooperation in COST Action TU0901 [29] with members from 29 European countries and institutions from three non-COST countries (New Zealand, Australia and Canada). At WG meetings, workshops, symposia etc., experience with regulations, classification schemes and constructions are shared among TU0901 member countries, while discussing and preparing proposals for harmonized descriptors and a European acoustic classification scheme for dwellings.

The present paper provides input to discussions in the Nordic countries as well as to Silent Spaces [28] and TU0901 [29].

References

[1] DS 490:2007, “Lydklassifikation af boliger”. (Sound classification of dwellings), DK.

[2] SFS 5907:2004, “Rakennusten Akustinen Luokitus“, Finland. English version “Acoustic classification of spaces in buildings” published in July 2005.

[3] IST 45:2011, *“Hljóðvist – Flokkun íbúðarog atvinnuhúsnæðis” (Acoustic conditions in buildings - Sound classification of various types of buildings”*, Icelandic Standards, Iceland). For brief information in English, see Steindor Gudmundsson. “A New Acoustics Classification Standard, and Revised Acoustic Demands in a new Building Code in Iceland”. Forum Acusticum 2011, Aalborg, Denmark, 2011..

[4] NS 8175:2008, “Lydforhold i bygninger, Lydklassifisering av ulike bygningstyper” (Sound conditions in buildings - Sound classes for various types of buildings), Norway.

[5] SS 25267:2004, *"Byggakustik – Ljudklassning av utrymmen i byggnader – Bostäder"* (Acoustics – Sound classification of spaces in buildings – Dwellings). Sweden.

[6] DP INSTA-B 122, "Sound classification of dwellings" Revised Final DP INSTA 122, Aug. 1998. INSTA-B Committee on sound classification, Norwegian Council for Building Standardization.

[7] Building Regulations 2010, Danish Enterprise and Construction Authority, Danish Ministry of Economic and Business Affairs. http://www.ebst.dk/file/155699/BR10_ENGLISH.pdf

[8] RakMK C1:1998, The National Building Code of Finland: C1 Sound insulation and noise abatement in building. Regulations and guidelines. http://www.finlex.fi/pdf/normit/1917-c1.pdf

[9] Byggingarreglugerd 2012 (Building regulations 2012). www.mannvirkjastofnun.is/library/Skrar/Byggingarsvid/Byggingarreglugerd/Byggingarreglugerd_2012.pdf

[10] Teknisk Forskrift 2010 (TEK'10) Technical Regulations under the Planning and Building Act 1997, National Office of Building Technology and Administration, Norway. www.lovdata.no/cgi-wift/ldles?doc=/sf/sf/sf-20100326-0489.html. See also DIBK Byggeregler. Veiledning om tekniske krav til byggverk. Direktoratet for byggkvalitet. http://byggeregler.dibk.no/dxp/content/tekniskekrav/13/

[11] Regelsamling för byggande (Building regulations), BBR 2012, Boverket 2011. http://www.boverket.se/Global/Webbokhandel/Dokument/2011/Regelsamling-for-byggande-BBR.pdf

[12] B. Rasmussen, "Sound Classification of Dwellings – A Diversity of National Schemes in Europe". Forum Acusticum 2011, Aalborg, Denmark, 2011.

[13] B. Rasmussen, "Sound Classification of Dwellings – Quality Class Ranges and Class Intervals in National Schemes in Europe ". EuroNoise 2012, Prague, Czech Republic, 2012.

[14] B. Rasmussen, "Facade sound insulation comfort criteria in European classification schemes for dwellings", EuroNoise 2006, Tampere, Finland, Paper ID 434.

[15] B. Rasmussen, "Sound insulation of residential housing - Building codes and classification schemes in Europe". Chapter 114 in Handbook of Noise and Vibration Control. Wiley & Son, USA, 2007.

[16] B. Rasmussen, "Sound classification schemes in Europe - Quality classes intended for renovated housing". SUBURBAN 2010 "Improving the Quality of Suburban Building Stock". University of Malta, 2010.

[17] B. Rasmussen, "Sound insulation between dwellings – Requirements in building regulations in Europe". Appl. Acoustics, 2010, 71(4), 373-385. http://dx.doi.org/10.1016/j.apacoust.2009.08.011

[18] B. Rasmussen & J.H. Rindel, "Sound insulation between dwellings – Descriptors in building regulations in Europe". Appl. Acoustics, 2010, 71(3), 171-180. http://dx.doi.org/10.1016/j.apacoust.2009.05.002

[19] B. Rasmussen, "Sound insulation between Dwellings – Overview of the Variety of Descriptors and Requirements in Europe". Forum Acusticum 2011, Aalborg, Denmark, 2011.

[20] ISO 717:1996, "Acoustics - Rating of sound insulation in buildings and of buildings elements". Note: ISO 717 is under revision in ISO/TC 43/SC 2/WG 18.

[21] ISO 140, "Acoustics – Measurement of sound insulation in buildings and of building elements". Note: Field parts are Nos. 2, 4, 5, 7, 14, 1991-2004. Under revision in ISO/TC 43/SC 2 WG 18.

[22] B. Rasmussen & J. Lang, "How much protection do the sound insulation standards give and is this enough?" EuroNoise 2009, Edinburgh, UK. Paper ID 0529.

[23] "European Directive 2002/49/EC of 25 June 2002 relating to the assessment and management of environmental noise". Note: Often referred to as the Environmental Noise Directive or END. Europe - Environment - Noise Policy. http://ec.europa.eu/environment/noise/directive.htm; http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2002:189:0012:0025:EN:PDF

[24] SS 25268:2007, "Byggakustik - Ljudklassning av utrymmen i byggnader - Vårdlokaler, undervisningslokaler, dag- och fritidshem, kontor och hotell" (Acoustics - Sound classification of spaces in buildings - Institutional premises, rooms for education, preschools and leisure-time centres, rooms for office work and hotels). Sweden.

[25] H. Helimäki & B. Rasmussen, "Airborne sound insulation descriptors in the Nordic building regulations – Overview special rules and benefits of changing descriptors". BNAM 2010. SINTEF Byggforsk, 2010.

[26] K.Hagberg & B. Rasmussen, "Impact sound insulation descriptors in the Nordic building regulations – Overview special rules and benefits of changing descriptors". BNAM 2010. SINTEF Byggforsk, 2010.

[27] NKB (1994): "Lydbestemmelser i de nordiske lande." (Acoustic regulations in the Nordic countries). Nordisk Komité for Bygningsbestemmelser, NKB 1994:1. Helsinki, Finland.

[28] Silent Spaces, Interreg IV project 2010-2013. http://www.interreg-oks.eu/en/Menu/Projects/Project+List+%c3%96resund-Kattegat-Skagerrak/Silent+Spaces

[29] COST Action TU0901 "Integrating and Harmonizing Sound Insulation Aspects in Sustainable Urban Housing Constructions", 2009-2013, http://w3.cost.eu/index.php?id=240&action_number=TU0901 (public information at COST website) or www.costtu0901.eu / (Action website).