

CHANGES IN NORWEGIAN SOUND QUALITY CLASSIFICATION STANDARD

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ABSTRACT

Norwegian standard for sound classification NS 8175 [1] is closely connected to technical regulations for buildings. The standard was revised in 2005 and 2008. The latest revisions were mainly caused by changes in building regulations and guidelines. The technical regulations [2] are valid for all kinds of buildings and the general requirements apply between areas of utilization, for example between two dwellings. Since the regulations are valid for all inhabitants, e.g. for sight or hearing disabled persons, some of the limits in NS 8175 had to be adjusted. Special limits for reverberation time valid for disabled persons in the schools, kindergartens etc. were to be made common for all.

In addition a national guideline T-1442 [3] for area planning was published for outdoor noise in 2004, and the limit values in the standard were changed in 2005. International and European standards include handling of measurement uncertainty which users consider confusing when comparing the results with limit values. How should the uncertainty be taken into consideration? In the ongoing and future revisions of measurement standards in Norway, the uncertainty is included. The measurement results, calculated as expected value, are compared to the limit values. Changes in requirements and limit values will be shown.

1. INTRODUCTION

Nordic countries cooperated on a sound classification system for dwellings in INSTA, and a draft Nordic standard was sent out for comments in 1997 [4], but it failed to become a common Nordic standard. Most of the Nordic countries published afterwards similar national standards. The first edition of the Norwegian sound classification standard, NS 8175, was published in 1997. NS 8175 was revised in 2005 and 2008.

The Norwegian standard contains a classification system with four sound classes. Class A has the highest sound insulation and lowest noise levels, and Class D is for old buildings that are worthy of preservation. The regulations are considered fulfilled when Class C is applied. Technical regulations [2] apply for all kinds of buildings and specify general requirements. The standard specifies limit values for the most types of buildings concerned by the technical regulations, not only dwellings. Limit values in the standard are tabled for reverberation time (absorption), airborne and impact sound insulation and for different sources of noise. The standard differentiates between environmental sources and building service equipment.

2. BACKGROUND

In the last years, accessibility in buildings for all kinds of disabled people has been in public focus and is also required by the technical regulations. As a consequence, specifications given for hearing and sight disabled people had to be reconsidered in NS 8175. Also, a new national standard based on universal design of building works and adjacent outdoor areas is in preparation [5].

The previous edition of NS 8175 contained specific limits for service equipment that did not comply with the revised regulations any more. Public responses on the contents of the standards were collected and discussed. Several kinds of noise or sound insulation problems and practical solutions were considered during the updates. For outdoor noise, recommendations in T-1442 [3] for area planning use aiming to prevent prospective noise annoyance through good planning by the local authorities, is applied. The limits in NS 8175 were harmonized with these guidelines.

3. CHANGES IN THE STANDARD

3.1. Reverberation time

Due to accessibility in buildings for disabled people, the specific reverberation times for hearing and sight disabled people were made valid for all. This means that all classrooms and kindergartens have to be designed in order to meet these more stringent requirements. Limit values for reverberation time in kindergartens, day-care facilities for schoolchildren and first-year classrooms, specified according to sound quality class, are shown in table 1. The specified limit values apply to the space averaged reverberation time in each of the octave bands 125 Hz, 250 Hz, 500 Hz, 1000 Hz and 2000 Hz, set pursuant to NS 8173 [6]. For the 1/1-octave band 125 Hz, the limit value can be increased up to 40 %. Since NS-EN ISO 3382-2 [7] was published in June 2008, it will replace the national measurement standard.

Table 1. *Sound quality classification of kindergartens, day-care facilities for schoolchildren and first-year classrooms. Upper limit values for reverberation time T*

Type of space	Class A <i>T</i> s	Class B <i>T</i> s	Class C <i>T</i> s	Class D <i>T</i> s
In day rooms in kindergartens, day-care facilities for schoolchildren and first-year classrooms	0,3	0,5	0,6	0,6
In stairwells / common corridors	0,8	0,8	0,9	1,2

The acoustic conditions in open plan teaching environments for people with visual and hearing impairments should meet internationally recommended guidelines [8]. Large classrooms / auditoria / open plan teaching environments require special acoustic regulation in order to achieve sufficient speech intelligibility or other desired characteristics. Limit values for reverberation time will therefore vary according to the use of the area, and reverberation time alone will not be a sufficiently descriptive factor.

3.2. Airborne sound insulation

The changes in building traditions in Norway during the last decades have raised new noise problems and uncertainty of requirements for sound insulation. The outer walls are traditionally built with less sound insulation than the walls between dwellings. The necessity for noise reduction of outer walls has mostly been relevant in cases with high outdoor noise levels.

Open air porticos or external stairs, especially towards courtyard, have become quite common and introduce such a noise problem. Application of traditional sound insulation limit values for common

corridors and stairwells is not practical or necessary in most cases, and the outdoor walls do not have well enough sound insulation. As a consequence, limits for airborne sound insulation were set for outer walls, between dwellings and portico/external stairs, as shown in the second row of table 2.

Table 2. Sound quality classification of dwellings with minimum limit values for airborne sound insulation

Type of space	Class A $R'_w + C_{50-5000}$ dB	Class B $R'_w + C_{50-5000}$ dB	Class C R'_w dB	Class D R'_w dB
Between dwellings, and between dwellings and common areas (common corridors, portico, stairwells, stairs etc.)	63	58	55	50
Between dwellings, and portico/external stairs with habitable rooms directed towards these	53	48	45	40
Between dwellings and business and service premises, parking facilities, etc.	68	63	60	55
Between rooms in the same dwelling (at least to one of the rooms in the dwelling)	48	43	-	-

3.3. Impact sound insulation

Most of the Nordic countries have introduced some additional criteria for measurement of impact sound levels between rooms that have great difference in size. EN ISO 140-14 [9] gives guidance for improving measurements in special situations, but it is not enough to avoid unreasonable criteria for sound insulation in the practical solutions. In NS 8175, a criterion of $V = 100 \text{ m}^3$ when calculating L'_n for dwellings, was set when the volume of the recipient room V is greater than 100 m^3 . There seems to be no obvious reasons to make different solutions for such measurements. Low frequency impact noise from walking is another problem that has not been solved although various efforts have been made.

3.4. Noise from service equipment

National regulations contain limit values for noise from service equipment when the equipment is necessary for the building services. In class C, limit values for sound level from service equipment in dwellings are given as A- and C-weighted maximum sound pressure level and as A-weighted equivalent sound pressure level. A European standard NS-EN ISO 16032 [10] was published in 2004 with more stringent measurement instructions than in the previous national standard. Often in practise, simplified measurements are made depending on the purpose.

There is no international standard that describes methods for outdoor measurements of noise from service equipment. The Norwegian regulations require satisfactory outdoor noise levels from service equipment. The former national standard which was replaced by NS-EN ISO 16032, is therefore being revised and will contain guidelines for outdoor measurements on noise from service equipment [11].

Previously, the national regulations opened up for an exception on noise from service equipment that can be controlled by the exposed person in the same dwelling. This exception is not any longer pursuant to the regulations and it has been deleted in NS 8175. This means that the requirements for noise from service equipment concern all kinds of housing, also detached-houses and one-family

houses. This rises questions on how to put limits for noise from a kitchen ventilator, e.g. forced ventilation, and from water and sanitary equipment. There was not sufficient knowledge on how to put reasonable noise level limits for such equipment in the same dwelling. Therefore a general requirement on satisfactory sound conditions together with recommended air change and ventilation volume was applied without quantifying the internal sound level limits for such sources.

3.5. Noise from outdoor sources

The European Directive on noise mapping has been implemented in Norway as a regulation. Additionally, the State pollution control has implemented same type of requirements in a recommendation on noise management in land-use planning T-1442 [2]. The new limit values are given as L_{den} and as statistical A-weighted maximum sound levels $L_{p,AFmax,95}$. The indoor levels are given as $L_{p,AeqT}$ -values. New measures were needed for sound classification (see table 3) and noise measurement methods to verify these limits. Consequently, new Norwegian standards [12, 13] have been prepared for measurement of noise from road traffic, for application on control of the new recommendations and regulations. A comparable method for rail road traffic is in preparation.

The guideline deals with three noise zones, white, yellow and red. The white noise zone has no specific noise reduction requirements. T-1442 recommends different regulations for noise sensitive use of areas in the yellow and red noise zones. The yellow noise zone is principally a ‘precautionary zone’. New noise sensitive buildings as dwellings, hospitals, nursing homes and other institutions, recreational buildings, schools and kindergartens, can be established if the noise conditions are documented to be satisfying. Therefore, an acoustic assessment is compulsory in all plans concerning new noise sensitive building categories in this zone.

In the red zone, new dwellings, hospitals, nursing homes and other institutions, holiday homes/cottages, schools and kindergartens should be avoided. Reconstruction of existing dwellings is allowed, provided that the number of accommodations remains the same. An acoustic assessment will then be obligatory and recommended noise limits should, as far as possible, be fulfilled. Local authorities can allow new dwellings in town centres and corresponding areas.

Table 3. *Sound quality classification of dwellings with upper limit values in outdoor areas*

Type of space	Measure	Class A	Class B	Class C	Class D
Sound level in outdoor areas and outside windows, from other outdoor sound sources	L_{den} (dB) for noise zone ¹⁾	Class C – 10 dB ²⁾	Class C – 5 dB ²⁾	Lower limit for yellow zone	Yellow zone
<p>1) The noise zones are related to the Ministry of the Environment’s Guidelines for noise management in land-use planning. Limit values for the noise zones in these guidelines for land-use planning vary according to the type of outdoor sound source. The sound level in L_{den} from a single sound source or the combined level from several sources shall not exceed the limit value.</p> <p>2) Noise zone limits vary depending on the type of sound source. The lowest limit value is therefore set to $L_{den} = 30$ dB.</p>					

3.6. Measurement uncertainty

Uncertainty in measurement results shall be determined and reported in standards in order to be compared with the noise level limits. How the uncertainty is handled in regulations and guidelines (summing up, no reflection etc.), is considered as an authority matter. In case no instructions or

criteria are given, the sound classification standard NS 8175 specifies that the measurement result (given as expected value) is compared with the limit value.

As an example, the measurement result for A-weighted equivalent continuous sound pressure level may be given for low number of measurements as follows:

$$L_{\text{eq},x} = \overline{L_{p\text{Aeq},T_n}} + \frac{\ln(10)}{20} \sigma^2 \text{ dB} \quad (1)$$

Where $\overline{L_{p\text{Aeq},T_n}}$ is the arithmetic mean of n measured values, and σ is the total standard deviation of four or less number of measurements (empiric standard deviation s is used when more than four measurements are made).

4. CONCLUSIONS

The sound classification of buildings and renewal of the limits and requirements is an ongoing process, especially due to the connection with the technical regulations, and also due to international harmonization of the standards. New problems for discussion arise with development and political processes.

More knowledge on how to quantify the internal sound level limits for service equipment, e.g. from a kitchen ventilator (e.g. forced ventilation) and water and sanitary equipment in the same dwelling, is needed. Requirements for satisfactory sound conditions have to comply with recommended air change and ventilation volumes.

The limits given in relation to the technical regulations have to be verifiable. Therefore, practical, harmonized measurement methods for external noise are needed for control of legal limit values. Although national standards have been prepared, international cooperation on such standards may benefit the quality.

International methods for determination of measurement uncertainty have become complicated. The application seems not to be practical. Simple guidance is needed for evaluations and calculations. On the other hand, handling of the measurement uncertainty, setting limit values and the consequences to the building tradition are not clear. Qualified guidance and application of measurement uncertainty and use in legal criteria would be helpful.

5. REFERENCES

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- [13] NS 8174-2 *Acoustics - Measurement of sound pressure level from road traffic - Part 2: Survey method.* Standards Norway, 2007. (In Norwegian)