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THE N_{10} VALUE A COMPARISON VALUE FOR SPEECH SOUND ABSORPTION FOR OBJECTS

N_{10} has been in use since 2015 and was first presented in a guide for procurement issued by Kammarkollegiet, which is a state authority under the Swedish Ministry of Finance.

This document defines the method of how to calculate a N_{10}-value based on measurement results expressed as equivalent sound absorption area evaluated according to latest version of ISO 20189.

N_{10} is a single number value for objects intended for comparison of the sound absorption performance of single objects used for interiors, such as desk screens, single wall absorbers, chairs etc.

This document is intended to be a complement to valid standards and is free to be used by any laboratory or company.

When reporting an N_{10}-value this document shall be used as reference.

APPROVAL

Involvement	Name	Organization	Signature and approval date
Prepared by	Joachim Schubert	Acoustic Facts	JS/2026-08-14
Approval	Pontus Thorsson	Akustikverkstan Lab AB	PT/2026-08-14

CHANGE LOG

Date/issue	Change Reason

1. SCOPE

The method describes calculation of N_{10}, a single number value representing the speech relevant sound absorption of single objects. N_{10} is calculated from laboratory measurement results and is developed to be used for comparison of products.

The method is intended to be a complement to valid standards.

2. FIELD OF APPLICATION

The calculation method applies to new and existing measurement results for all types of screens, furniture and single objects intended for interior use, measured according to ISO 20189.

NOTE 1: ISO 20189 is referring to the standard ISO 354.

NOTE 2: For wall- or ceiling-mounted sound absorbers that can be assembled to form a surface area that is greater than or equal to 10 m², the calculation of a single number value shall be carried out in accordance with ISO 11654.

3. REFERENCES

All references to ISO-standards in this documents are made to the latest approved version.

ISO 20189 *Acoustics – Screens, furniture and single objects intended for interior use- Rating of sound absorption and sound reduction of elements based on laboratory measurements.*

Thorsson, P. (2023). *The N_{10} – A Comparison Value for Speech Sound Absorption for Objects.* Proceedings of Forum Acusticum 2023, pp. 5347–5351. DOI: 10.61782/fa.2023.1239.

4. DEFINITIONS

N_{10} value (pronounced '*N-ten value*')
Single value number giving a quick indication of how many of a specific product (N) are required to reach 10 m^2 of speech relevant sound absorption area.

NOTE 3: A lower N_{10} value means that the product absorbs speech more effectively, but that does not necessarily make it better in all situations. The primary purpose of N_{10} is to facilitate comparisons between products of similar size, thus making price indications easier for practical installation.

A_{dim} dimensioning sound absorption area
Equivalent sound absorption area A_{dim} as a mean value of three specific 1/3 octave frequency band, where *dim* relates to the dimensioning octave frequency band. The unit is absorption area in m^2 or alternatively m^{2}Sabine.

5. METHOD

5.1 PRINCIPLE

The method is a complement to the evaluation of measurements results according to valid standards and delivers a size-dependant single number value for comparison of products speech relevant sound absorption.

5.2 MEASUREMENT RESULTS

The measurement must follow ISO 20189 and be valid for the specific construction and size of the product.

The measurement results must be valid for the way the product is used. For example, an office screen must be measured standing upright on the floor and a suspended sound absorber must be measured hanging freely with sufficient distance to any walls or ceilings.

NOTE 4: Interpolated results according to ISO 20189 is also allowed.

NOTE 5: Annex A of ISO 20189 states that single object sound absorption for 1/3 octave band values is rounded to 0.1 m^2. This document allows for more decimals.

5.3 CALCULATION METHOD

The N_{10} value is calculated from a specific product's sound absorption area at the dimensioning speech relevant octave band by formula (1), where A_{dim} is calculated from the mean value of the product's sound absorption area in the 1/3 octave bands 400 Hz, 500 Hz and 630 Hz (belonging to the octave band 500 Hz) according to formula (2).

$$N_{10} = \frac{10}{A_{dim}} \qquad (1)$$

$$A_{dim} = \frac{A_{400} + A_{500} + A_{630}}{3} \qquad (2)$$

If the sound absorption area is lower in one of the octave bands 1, 2 or 4 kHz compared to 500 Hz, the corresponding lowest mean value for the 1/3 octave bands (included in the octave band), is used in the N_{10} evaluation.

The number of decimals used for input in formula 1 and 2 is given in appendix A.

The N_{10} value is given with one decimal for $N_{10} < 10$ and without decimals for $N_{10} \geq 10$. For $N_{10} \geq 100$, it is reported with 2 significant numbers, the value rounded to the nearest tens.

6. REPORTING

A calculated N_{10} value may be included as an additional evaluation of the results when reporting a sound absorption measurement.

When calculating N_{10} for earlier measurements a reference to the original measurement report must be included.

When reporting an N_{10}-value this document shall be used as reference.

APPENDIX A – ACCURACY OF CALCULATION

N_{10} is calculated based on available measured sound absorption area from a new or existing measurement and is presented with 1-2 significant numbers depending on the products sound absorption.

The number of decimals used as input depends on how large the measured maximum sound absorption area is for all used 1/3 octave bands.

- A_{dim} is calculated with at least 2 decimals if the maximum absorption area is between 1 m^2 and 10 m^2.
- If the maximum sound absorption area is greater than 10 m^2, at least 1 decimal is used.
- If the maximum sound absorption area is less than 1 m^2, at least 3 decimals are used,
- and if it is less than 0.1 m^2, 4 decimals are used.

This is valid for both A_{dim} and the 1/3 octave bands in formula 2.

The normative appendix A of ISO 20189 describes presentation of sound absorption area: In the 1/3 octave bands from 100 Hz to 5000 Hz, the values shall be rounded to 0.1 m^2.

Consequently, the main absorption result for a product may be rounded in the report. In such cases it is better to use the measured sound absorption area for the whole sample (including all objects).

Measured reverberation times T_1 (empty) and T_2 (containing all specimen) are reported with 2 decimal places according to ISO 354, allowing for 2 decimal places for A_{dim}. Even if ISO 20189 states 1 decimal.

> NOTE 6: The conventional rules for significant figures are not strictly applied to calculations based on existing measurements, meaning that fewer decimal places may be used, although this is not preferred.

APPENDIX B – ACOUSTIC CONTEXT FOR THE N_{10} VALUE

Furniture that is covered by the ISO 20189:2018 standard is primary used in offices and schools. The most common sound exposure in those built environments is speech. A comparison value for furniture should thus be based on speech in order to be a relevant measure. The obvious starting point for a relevant measure is thus to weight an objects sound absorption area with the sound power of speech. Speech spectra from the standards ISO 3382-3:2022 (equivalent to the speech spectrum in ANSI S 3.5-1997, R 2007 and IEC 60267-16:2020 are used in this document. The spectra are presented in Table 1. The IEC spectrum in the table is calculated to a unisex spectrum as the energetic mean of male and female spectrum.

f (Hz)	ISO 3382	IEC 60268
125	-23.6	-16.1
250	-11.7	-4.3
500	-2.6	-4.5
1 k	-5.4	-7.7
2 k	-11.4	-12.8
4 k	-17.6	-16.6

Table A.1. A-weighted frequency spectra (*DL*) of speech from standards. The value in the table are dB values that sum energetically to 0 dB(A)

It is clear in Table 1 that there are significant differences between the standards. The speech-weighted absorption area is calculated according to Equation A.1.

$$A_{speech} = \sum_{i=1}^{6} A_i 10^{\frac{DL_i}{10}} \qquad \text{(A.1)}$$

Where i denotes the frequency band index (i = 1 corresponds to the 125 Hz octave band and i = 6 corresponds to the 4 kHz octave band). However, in the ISO 3382 spectra the 500 Hz octave band is significantly stronger than all other bands. In the ISEC 60268 spectra the 250 Hz and 500 Hz are almost identical. These can possibly be used to simplify the evaluation. Figure A.1 shows the correlation between the weighted absorption calculated according to Equation A.1 and just by using the strongest octave band for each standard respectively. In the graphs, measured absorption areas for 196 products are used, data provided by the company Acoustic Facts. From the graphs it is clear that it seems sufficient to evaluate the speech sound absorption from the strongest octave band of speech.

From the two used standards, the ISO standard is chosen in order to get as dynamics as possible in the final measure. The dynamics using the 500 Hz band is larger than the dynamics using the 250 Hz band, see Figure A.2 where the 500 Hz band results in more even distribution of products. The 250 Hz band results in a denser population at power values than the 500 Hz band. This means that it is more probable that an absorption performance difference between two products is probable by using the 500 Hz octave bad than the 250 Hz band. The conclusion is here that the speech spectrum in ISO 3382-3, and thus also in ANSI S 3.5, is better suited for comparison measures.

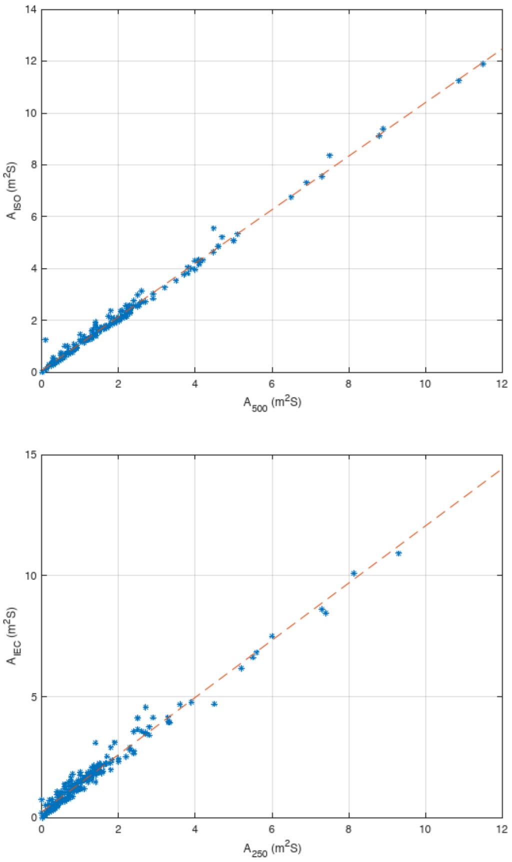

Figure A.1. Correlation between full speech spectrum calculation and a simplified calculation with only the strongest frequency bands.

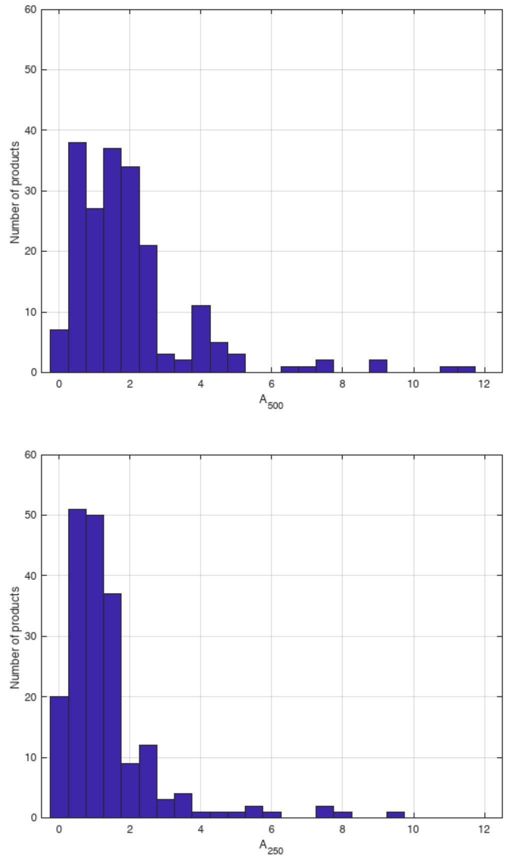

Figure A.2. Distribution of the products for 500 Hz and the 250 Hz octave band respectively.

The aim for the N_{10} measure is to get speech absorption comparison measure, and that this measure is possible to use for product choice. This implicitly means that the N_{10} most probably also will function as design measure in product development. With this in mind, it is dangerous to have a measure that is based on one octave band only. The probable outcome is that we would see many products that are optimized for sound absorption in the 500 Hz Octave band, and those products are not very effective for speech absorption. An additional requirement is added to the effective sound absorption to overcome this; the absorption area of the product should not be less than the value in the 500 Hz band in any higher octave band. If so, the smallest absorption area should be used.

There are so many different absorption values used today with different meanings, so the idea with N_{10} has been to come up an alternative unit, that is easier to understand for the intended users (i e the furniture industry). The alternative unit is chosen is to used amount of products (N), and more specific the amount of products (of a specific size) that would be needed to obtain 10 m2 of speech absorption. The reason for using 10 m^2 as a normative size is that this specific size is already in use in several acoustic standard, e g when normalizing sound pressure level difference (D_n) or normalized impact sound level (L_n).

APPENDIX C – INITIATIVE FOR THE N_{10} VALUE

The original initiative came from the Swedish furniture manufacturers and was the results from experiences with badly formulated procurements, and the evaluation of procurement replied. There were simply no rules on how furniture's sound absorption should be evaluated or presented. This was experienced as especially sensitive for the large-scale governmental procurement issued by the large-scale procurements issued by the Swedish Legal, Finance and Administrative Service Agency (Kammarkollegiet). It was very important for the furniture manufacturers that relevant procurement rules regarding sound absorption were included in those procurements. The manufacturer was not allowed to sell acoustic products to any governmental institution if it did not pass the procurement.

On the other hand, frivolous manufacturers that did pass the procurement with irrelevant or very unspecific acoustic documentation could sell their furniture at a lower cost. For instance, office screens could pass the procurement with absorption measurements for a similar material as in the screen filling but measured as a suspended ceiling with 200 mm air gap behind.

There are also many creative examples of how to reach sound absorption class A for an office screen from the evaluation of weighted sound absorption coefficient according to EN ISO 11654:1997. These examples include measuring the screen flat on the floor, using two screens to create an extra thick screen or using only the one-sided surface area in the evaluation.

APPENDIX D – ABOUT MOUNTING CONDITIONS FOR MEASUREMENTS

The normative appendix E of ISO 20189:2018 describes mounting conditions for measurements of objects in laboratories.

For measurements used to calculate the N_{10} value according to this document, the following interpretations are allowed:

- Distance between objects is interpreted to be 2-meter distance between centre points.
- The total measured sound absorption area shall always exceed 1,0 m^2 from octave frequency bands 500 Hz and higher.
- If measuring 1 object it shall be measured in 3 positions. For 2 or more objects, one measurement position is sufficient.

APPENDIX E – EXAMPLES OF CALCULATION OF N_{10}

Figure D.1 shows an example of calculation of N_{10} for a desk screen measured standing upright on the floor.

f (Hz)	Sound absorption area per object (m^2Sabine)		
50	0.38		
63	0.30	0.33	
80	0.31		
100	0.36		
125	0.41	0.44	
160	0.56		
200	0.62		
250	0.68	0.73	
315	0.88		$A_{dim} = \frac{1.12 + 1.36 + 1.42}{3} = 1.30\ m^2S$
400	1.12		
500	1.36	1.30	$N = \frac{10}{A_{dim}} = \frac{10}{1.30} = 7.7$
630	1.42		
800	1.51		
1000	1.49	1.51	
1250	1.53		
1600	1.60		
2000	1.57	1.62	
2500	1.68		
3150	1.82		
4000	2.03	1.93	
5000	1.93		

Figure D.1 Example of calculation of N_{10} for a desk screen with dimensioning sound absorption area at octave band 500 Hz.

Figure D.2 shows an example of calculation of N_{10} for a sound absorbing wall panel measured lying flat on the floor.

f (Hz)	Sound absorption area per object (m^2Sabine)	
50	0.05	
63	0.05	0.06
80	0.07	
100	0.05	
125	0.15	0.15
160	0.25	
200	0.50	
250	0.78	0.77
315	1.04	
400	0.85	
500	0.81	0.81
630	0.76	
800	0.74	
1000	0.69	0.72
1250	0.73	
1600	0.59	
2000	0.61	0.58
2500	0.55	
3150	0.58	
4000	0.55	0.55
5000	0.53	

$$A_{dim} = \frac{0.58 + 0.55 + 0.53}{3} = 0.553^{*}\ m^2S$$

$$N = \frac{10}{A_{dim}} = \frac{10}{0.553} = 18$$

**The conventional rule governing significant figures is not applied strictly when calculations are derived from existing measurements.*

Figure D.2 Example of calculation of N_{10} for a wall panel with dimensioning sound absorption area at octave band 4 kHz.