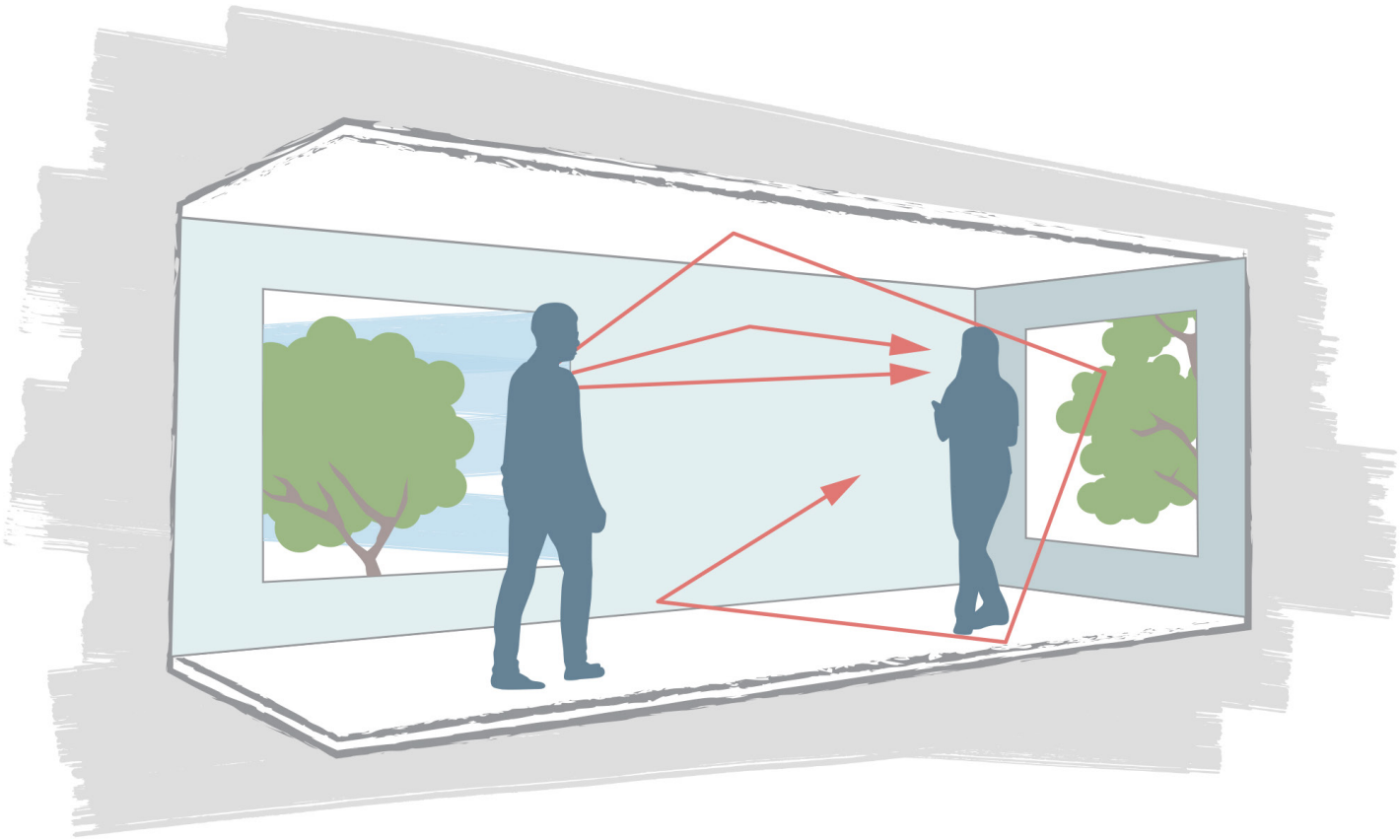
DeFelt®

Room acoustics and reverberation control

An engineered approach with felt panels

— Content

01 Introduction to Room Acoustics and the Phenomenon of Reverberation



Room acoustics is a critical discipline for ensuring the comfort and functionality of both residential and commercial spaces. A fundamental aspect of acoustic design involves the control of reverberation, which refers to the persistence of sound within a room after the sound source has ceased. Excessive reverberation, often perceived as echo or undesirable noise, can significantly impair speech intelligibility, hinder concentration, and generally degrade the overall sound quality of an environment. In settings such as offices, industrial halls, lecture rooms, and canteens, the primary objective of acoustic design is to reduce the mean sound pressure level (SPL) to ensure auditory comfort and enhance productivity.

The phenomenon of reverberation is quantitatively described by reverberation time (T), which is a key acoustic parameter frequently utilized in European standards for dimensioning acoustic treatments. The optimal reverberation time varies depending on the intended use of a room; a reverberation time that is too long leads to overlapping sounds, while one that is too short can make a room sound „dead”.

02 Key Acoustic Parameters and European Standards for Noise Reduction

Contemporary European acoustic standards, such as the **Austrian ÖNORM B-8115-3** and the **German DIN 18041,** commonly employ dimensioning functions based on either reverberation time (T) or the mean absorption coefficient (α_m). The stated goal of these standards is to achieve a consistent overall sound pressure level (SPL) reduction. The reduction in SPL (ΔL) is typically calculated using diffuse field theory, as expressed by the following formula:

$$\Delta L = 10 \cdot \log\left(\frac{A_1}{A_0}\right) = 10 \cdot \log\left(\frac{T_0}{T_1}\right) = 10 \cdot \log\left(\frac{\alpha_{m,1}}{\alpha_{m,0}}\right)$$

Where:

- A_0 and A_1 represent the equivalent sound absorption area before and after the application of sound absorbers, respectively.
- T_0 and T_1 denote the reverberation time before and after acoustic treatment.
- $\alpha_{m,0}$ and $\alpha_{m,1}$ signify the mean absorption coefficient before and after acoustic treatment.

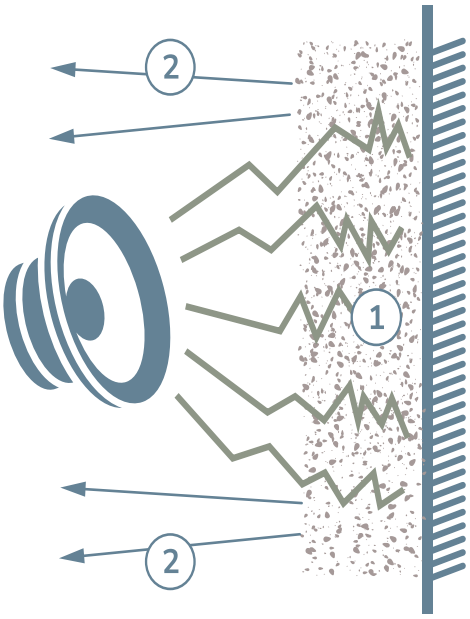
Standards like ÖNORM and DIN differentiate spaces based on their acoustic requirements, for instance, defining Group B spaces for areas primarily focused on noise reduction, such as workshops or call centers. However, a significant limitation arises because dimensioning functions based solely on room height, as often seen in ÖNORM and DIN, frequently fail to provide consistent SPL reduction irrespective of room size and shape. This is primarily because such formulas neglect two out of the three spatial dimensions of a room. Analyses have demonstrated that these approaches can lead to either undersizing small rooms or oversizing large rooms, resulting in absorption areas that are economically difficult to justify and challenging to implement in practice due to insufficient space for absorbers.

To address these limitations, an alternative approach is proposed: a target absorption area (A_1*) derived by multiplying the initial absorption area (A_0) by a constant (k), where ‚k' is determined by the desired SPL reduction (e.g., k=2 for a 3 dB SPL reduction).

$$A_1* = A_0 \cdot k$$

Key Acoustic Parameters and European Standards for Noise Reduction

This approach, within the framework of diffuse field theory, ideally ensures identical SPL reduction regardless of room geometry and initial acoustic properties. Furthermore, to correct for the inherent inaccuracies of diffuse field theory when dealing with varying room proportions, A_1* can be multiplied by a „form factor" – a linear function dependent on the room's height-to-length ratio (h/l). Geometric acoustics simulations have confirmed that the A_1* function, when combined with this form factor, significantly outperforms existing approaches in achieving balanced SPL reductions across a wide range of room sizes and geometries.



1 Noise and sound is absorbed by the acoustic material

2 Minimal sound is reflected back into the space

03 Felt and Felt Panels as Advanced Acoustic Materials

In response to the challenges of traditional acoustic dimensioning, felt and felt panels, particularly those manufactured from recycled polyethylene terephthalate (PET), have emerged as an increasingly popular and effective solution for interior acoustics. These products offer a unique combination of sophisticated aesthetics and high-quality sound insulation properties, effectively reducing unwanted noise and reverberation while enhancing interior design.

Key properties that define acoustic felt, such as those offered by **DeFelt**, include:

- **Acoustic Performance**: These materials possess a high capability for sound absorption. For DeFelt Acoustic PET Felt Panels, the Noise Reduction Coefficient (NRC) has been documented to exceed 0.8 when applied with a 50 mm air gap. This indicates a high level of sound absorption, making them highly effective in reducing reverberation.
- **Decorative Versatility:** Acoustic felt panels are available in a wide array of colors and finishes, allowing for the creation of modern, visually appealing, and acoustically optimized spaces. DeFelt specifically combines sophisticated aesthetics with its sound insulation properties
- **Environmental Sustainability:** A significant benefit of these materials is their composition. DeFelt products are manufactured entirely from recycled PET material. For instance, one square meter of DeFelt Felt is produced from approximately 88 recycled plastic bottles, thereby completing a critical recycling loop. The production process prioritizes environmental sustainability, aiming to reduce or eliminate the ecological footprint of the products.
- **Safety and Health:** The material is free from volatile organic compounds (VOCs), contributing to healthier indoor air quality. Furthermore, these panels are fire-rated, and DeFelt states that its products are tested and certified in accredited laboratories across Europe to ensure performance, durability, and safety.
- **Multifunctionality:** Beyond their primary acoustic function, felt panels are also designed to be ventilated, buffered, and tackable, offering additional practical applications in various environments.

04 DeFelt Products and Their Applications

DeFelt specializes in creating products based on fully recycled PET material, with each item meticulously crafted by a team of designers to meet client expectations. The company offers a broad range of acoustic products aimed at comprehensively improving room acoustics and enabling unique interior designs.

Prominent among **DeFelt's** offerings are the **DeFelt Acoustic Wall Panels,** also marketed as **WallAttract™**. These wall panels are specifically engineered to enhance sound quality and interior aesthetics, providing an elegant solution for reducing echo and noise. Their ease of installation makes them suitable for both residential and commercial applications.

Other acoustic and aesthetic products from **DeFelt** that contribute to comprehensive acoustic design include:

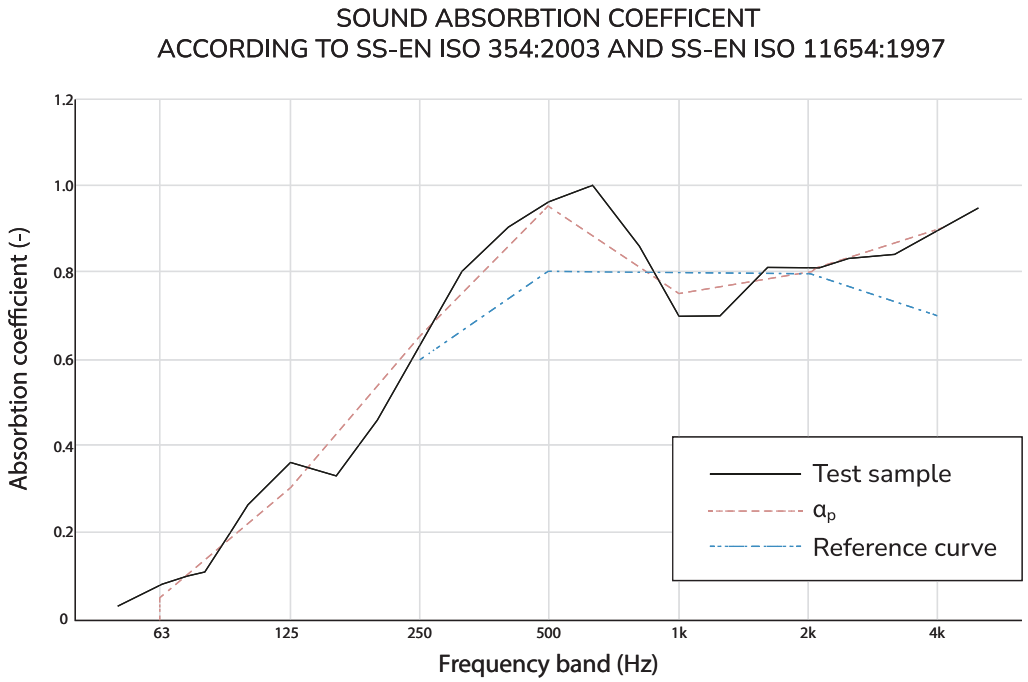
- Acoustic Ceilings
- Acoustic Baffles
- Felt Furniture
- Acoustic Dividers
- Acoustic ArtWall and Acoustic ArtWorks
- Acoustic FeltFrame
- Felt Organizers
- Lamp Shades

DeFelt also facilitates the creation of custom acoustic solutions, such as drop ceilings, office dividers, desks, and lamps, all tailored to specific client needs. Custom product design services are also offered, allowing for full personalization of acoustic solutions. The entire production process at **DeFelt's** Polish factory, from raw material selection to technological processes and quality control, is conducted with utmost care, ensuring the delivery of high-quality products.

DeFelt products, as decorative construction materials, undergo rigorous testing and certification to validate their technical properties and safety for use.

Reaction to Fire

A key aspect of building material safety is their reaction to fire. A specific **Acoustic PET Felt Panel** from **DeFelt**, with a declared thickness of 9 mm and a basis weight of 2200 g/m², was subjected to fire reaction tests at the Building Research Institute (ITB) Laboratory of Fire Research (LZP) in Poland. This was documented in research report LZP03-01361/24/Z00NZP, issued on August 29, 2024. The testing was conducted according to **PN-EN ISO 11925-2:2020-09**, titled „Reaction to fire tests – Ignitability of products subjected to direct impingement of flame – Part 2: Single-flame source test". The test conditions included both surface and edge flame impingement for an exposure duration of 30 seconds. The results indicated that while ignition occurred in all tested samples, the flame did not reach the 150 mm mark, nor did it cause the ignition of filter paper. The assessment of conformity with the criteria specified in **PN-EN 13501-1** (Classification of construction products and building elements with regard to reaction to fire) is provided in a separate classification report (No. 01361/24/Z00NZP).



In the broader context of decorative wall coverings, the **PN-EN 15102+A1:2011** standard (which implements **EN 15102:2007+A1:2011**) outlines specific requirements for properties, including reaction to fire. This standard defines fire reaction classes ranging from A1 to F, in accordance with EN 13501-1. **DeFelt Acoustic Felt Panels** are designed to be compliant with these stringent European standards.

Sound Absorption

The sound absorption properties of felt panels are paramount to their function. The **PN-EN ISO 354:2005** standard („Acoustics – Measurement of sound absorption in a reverberation room") is the established method for measuring reverberation reduction, with tests performed in accredited laboratories. Subsequent evaluation of the results is carried out according to **EN ISO 11654** („Acoustics – Sound absorbers for use in buildings – Rating of sound absorption"). As noted, **DeFelt** products demonstrate high sound absorption performance, with an NRC exceeding 0.8. Below you can see the results for various thickness and density of **DeFelt PET Felt** materials.

Measurement protocol	Test object	α_w	Absorption Class
M1 D	F-09-1500, direct fixing 0	.25(H) E	
M2 D	F-09-1500, E-60	0.45(MH) D	
M3 D	F-09-1500, E-100 0	.60(MH)	C
M4 D	F-09-1500, E-200 0	.80	B
M5 D	F-09-1900, direct fixing 0	.25(H) E	
M6 D	F-09-1900, E-60	0.50(MH) D	
M7 D	F-09-1900, E-100 0	.70(MH)	C
M8 D	F-09-1900, E-200 0	.85	B
M9 D	F-12-2400, direct fixing 0	.30(MH)	D
M10	DF-12-2400, E-60	0.55(MH) D	
M11	DF-12-2400, E-100 0	.70(MH)	C
M12	DF-12-2400, E-200 0	.90	A
M13	DF-24-4000, direct fixing 0	.50(MH)	D
M14	DF-24-4000, E-75	0.70(MH) C	
M15	DF-24-4000, E-100 0	.80(H) B	
M16	DF-24-4000, E-200 0	.95	A

Results evaluated according to SS-EN ISO 11654:1997. M and H are spectrum shape indications, which states where the sound absorption exceeds the shifted reference curve. For M it occurs at 500-1000 Hz and H occurs at 2000 – 4000 Hz.

Other Properties and CE Certification

The **PN-EN 15102+A1:2011** standard also addresses other crucial product characteristics:

- **Formaldehyde Emission:** This standard sets maximum permissible limits for formaldehyde content, with testing conducted according to EN 12149:1997, where applicable.
- **Thermal Resistance (Wärmedurchlasswiderstand):** The standard specifies that thermal resistance values can be adopted from EN 12524 or measured via EN 12667.

Conformity with the **PN-EN 15102+A1:2011** standard is verified through Initial Type Testing (ITT) and Factory Production Control (FPC). An FPC system, implemented and documented by the manufacturer, is designed to ensure that all products placed on the market consistently meet their declared performance characteristics. **DeFelt's** production facility has maintained an **ISO 9001** certified quality management system for many years, which aligns with the general requirements for FPC. Products that meet the requirements of the PN-EN 15102 standard are entitled to bear the **CE marking**, which conveys essential information about the product, manufacturer, applicable standards, and declared properties.

06 Conclusion

Effective acoustic design is indispensable for creating functional and comfortable spaces. Uncontrolled reverberation can significantly diminish the acoustic quality of rooms. The adoption of innovative solutions, such as felt panels made from recycled PET, represents a highly effective method for mitigating this challenge.

DeFelt products, including their **Acoustic Wall Panels (WallAttract™)**, exemplify the integration of advanced acoustic properties, sustainability, and aesthetic appeal. Their adherence to rigorous European standards for fire reaction (PN-EN ISO 11925-2, PN-EN 13501-1, PN-EN 15102+A1:2011) and acoustic performance (PN-EN ISO 354, EN ISO 11654) validates their high quality and safety. The long-standing ISO 9001 certified quality management system and CE marking further underscore **DeFelt's** technical and scientific commitment to manufacturing, providing clients with proven and effective solutions in room acoustics.

By choosing **DeFelt**, stakeholders invest in an optimal acoustic environment that is both efficient and aligned with principles of sustainable development.

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Please note that the actual appearance of DeFelt felt products may differ or vary slightly from the images shown in the catalog. This is because each type and batch of felt and fabric has its own unique characteristics. We view this as an advantage for each product is unique and unrepeatable. Keep in mind that the colors of PET, felts, and fabrics may vary slightly from what you see in the catalog. For the most accurate representation, we recommend referring to our sample book or sample individually sent.

Due to the production process of both fiber and PET felt, there may be slight variations in material between different production batches. Additionally, please take into consideration that PET panels have distinct left and right sides so always try to present only one side of the sheet. Due to the manufacturing process, the felt board may show differences in shade depending on the direction of laying. We recommend laying all pieces in one direction to avoid undesirable visual effects.This is particularly important to consider when installing larger structures, such as wall-mounted panels or acoustic drop ceiling.

DeFelt