SOIL & WASTE SYSTEMS IN BUILDINGS

Noise and noise reduction

wavin

Do you know the difference

between structure-borne and airborne sound?

Are you looking at the right data when choosing low-noise soil and waste pipes? To help you choose the right product, here we explain the difference between different noise measurements.

What are ‘structure-borne’ and ‘airborne’ sound?

When choosing soil and waste pipes, you need to be sure they will meet noise and technical installation requirements according to the threshold values in the Building Rules. But how can you be sure you are looking at the right noise data when choosing a low-noise pipe? Should you use the data for structure-borne sound or for airborne sound? And what’s the difference?

The wall thickness and density of the pipes determine how low-noise a soil and waste pipe is. The thicker and heavier the pipe, the lower the noise. The vast majority of soil and waste pipes are tested in impartial test laboratories – in many cases at the Fraunhofer IBP Institute in Germany. The pipes are installed in a test building to ensure uniform testing methods for all types of pipe.

Why is the difference important?

Fraunhofer IBP reports give two test results: **structure-borne sound** and **airborne sound**.We know that not everyone differentiates between the two measurements. Instead they choose a pipe based on the lowest measurement, which is structure-borne sound. In many cases, this represents no problem. But because the results from Fraunhofer IBP reports are taken from a test environment with specific materials from the building’s construction, structure-borne sound cannot be used as a direct indicator of structure-borne sound in any building. Depending on the choice of materials, structure-borne sound in an actual building will differ from the test results.

Following is an explanation of the two types of measurements and the consequence of basing your choice of pipe on the wrong data. We will also give you an insight into the Fraunhofer IBP test environment, and where the two results are measured.

Did you know?

WHAT A FRAUNHOFER IBP REPORT REVEALS

A Fraunhofer IBP report gives different noise measurements. Apart from structure-borne sound and airborne sound, Fraunhofer IBP also tests different flow rates in the pipes.

The figures normally used are for a noise measurement taken at a flow rate of two litres, which is the amount of water passing through the pipe from a standard toilet flush.

A Fraunhofer IBP report also shows the test construction in detail. For instance, it states which pipe supports and wall thicknesses are used, and describes the standards the test conforms to.

The difference between structure-borne and airborne sound

Airborne sound is the amount of noise that can be heard if standing in the same room in which the pipe is installed. airborne sound is reduced via the net weight of the material, or the encapsulation.

Structure-borne sound is the amount of noise that can be heard from the pipe after the noise from water passing through it has permeated into the building construction (walls, pipe supports, brackets). Structure-borne sound is reduced via the material's elasticity and insulation in the pipe supports and penetrations.

Structure-borne sound is not a certainty

Measurements for structure-borne sound often look good on paper, as they are often much lower than airborne sound, and lower than the requirement for noise from technical installations. But they offer no guarantee that you are complying with noise requirements overall throughout a given building project. Firstly, the pipe supports, wall brackets and wall materials have considerable influence on how much noise from the pipe is reduced. Structure-borne sound can only be used in those rooms where it permeates through the building construction, and not on the actual installation side of the pipes. Secondly, the test result can only be used if the pipes in a given building project are installed in the same materials as in Fraunhofer IBP's test facility.

Airborne sound is used during installation

Airborne sound can be used on the installation site, as it is a much more reliable figure. The noise that the pipe emits itself will be the same, regardless of how it is installed. But you can only use airborne sound on the installation site if the pipe runs in a shaft, or is enclosed in some other way. However, what you can do, is calculate how and with what you can encapsulate it to meet the building rule requirements.

Do not simply accept the test results

If using structure-borne sound as the benchmark when choosing low-noise soil and waste pipes, you can risk choosing a solution that cannot meet the building rule requirements in all rooms. However, if you use the airborne sound measurement, you have a certain amount of control over the project yourself. When it comes to reducing noise in those rooms where noise permeates through the construction, a calculation based on the materials to be used for a given project will be the best way of ensuring noise requirements are met.

The risk of simply accepting test results is that a test performed at an inspection may result in you being required to replace the pipes, or provide additional noise insulation around them – which takes time and money. **Using airborne sound from the pipe as benchmark** means that the reduction value for the building materials is deducted if, for instance, the pipe is installed behind plasterboard, a wall or a ceiling. The result is the level of noise the pipe will emit in a room on the installation side.

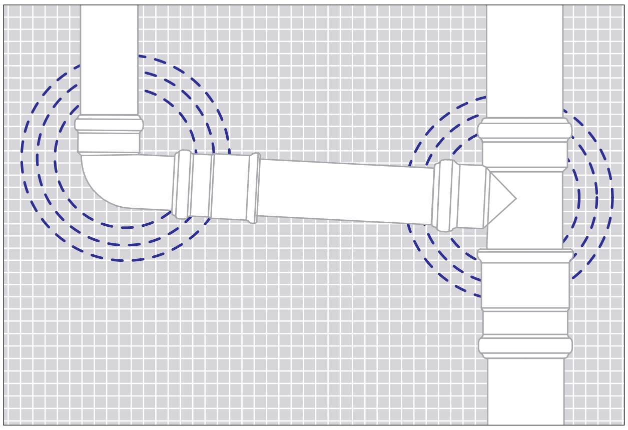
How does noise occur?

Noise is mechanical vibrations that can be defined as a pressure variation in air, water or vibrations of building elements.

How does noise occur?

- When water and air pass each other
- When waste water changes direction at branch pipes and in bends, or passes a reduction
- When water falls through a vertical soil and waste pipe, and hits a solid surface, such as the bend at the bottom.

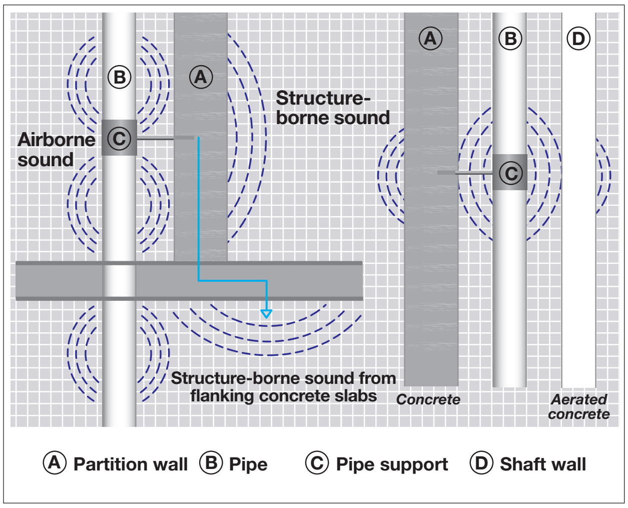
Examples of where noise can occur.



Examples of where noise can occur.

How does noise travel?

- Through water
- Through pipe walls
- Noise radiation from soil and waste pipes
- Via pipe support to building constructions
- Via radiation from surrounding building constructions



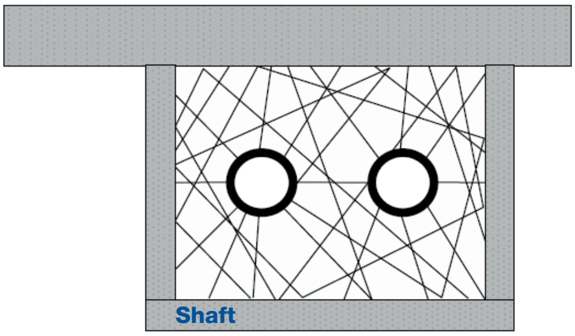
Example of noise radiation from flanking building constructions

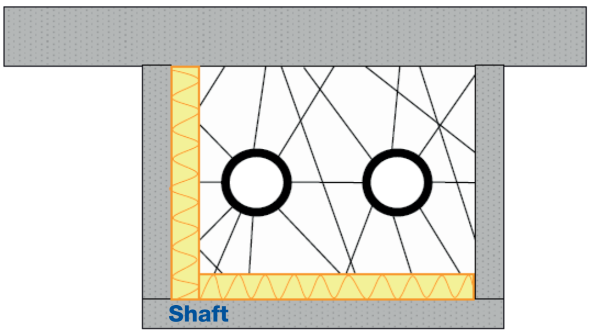
How noise can be further reduced:

- Reduce the water flow rate if possible
- Reduce water speed as much as possible
- Use soft direction changes, e.g. 2 x 45° bends, instead of 1 x 88.5° bend
- A 250mm pipe should be installed between two 45° bends when space permits in buildings with more then three storeys
- Use pipe supports with rubber inlays (reduce noise by up to 3dB(A))
- Mount pipe supports on the heaviest wall, which is most resistant to vibration
- Use the lowest possible number of pipe supports to limit transfer of noise to the wall. However, the max. distance between supports must be observed
- Avoid fixed connections between pipe and floor slabs as much as possible
- Separate pipes from building elements, e.g. by wrapping two or three layers of needle felt or fibre sheeting around the pipe.

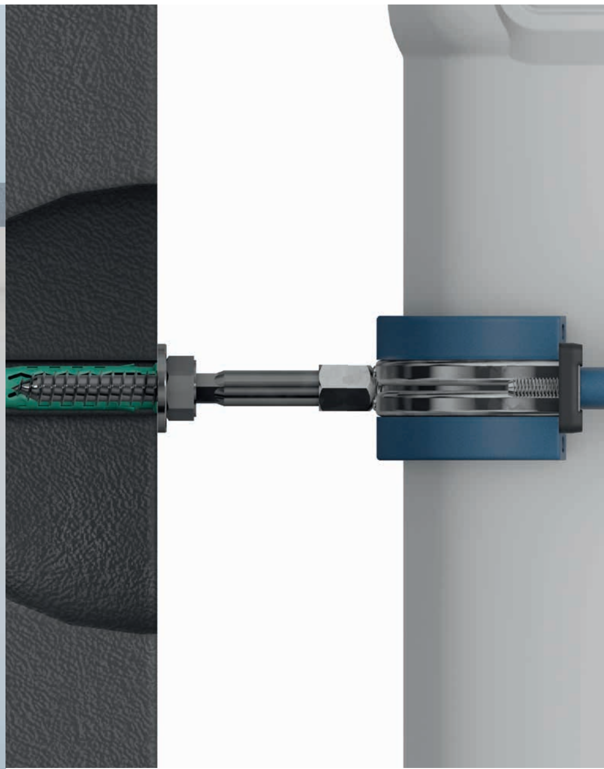
Airborne sound in shafts

Noise in shafts increases by 10dB(A) due to reflection from the shaft. By insulating two of the shaft sides with 30 mm mineral wool, improved absorption will prevent this.





Fraunhofer IBP test environment



The Fraunhofer IBP test environment

Noise measurements are performed in the test environment at the Fraunhofer IBP institute in Stuttgart, Germany on soil and waste pipes on the installation side, and in a room behind the installation wall two floors under the water inlet.

The importance of knowing the test environment for noise measurement lies quite simply in knowing the difference between the materials, dimensions, location and set-up of the elements in the test environment, compared to the situation the installer faces when you choose a low-noise pipe.

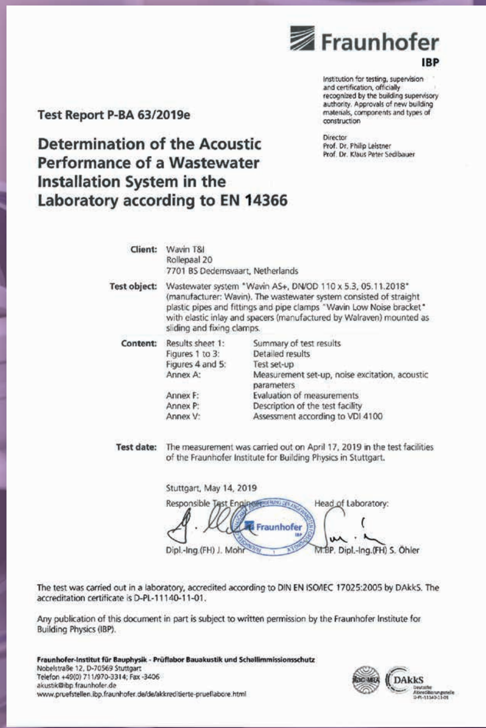
Soil and waste pipes are installed in the Fraunhofer IBP test environment on a 115mm plastered concrete wall with a density of 220kg/m^2, and a floor or reinforced concrete with a density of 440kg/m^2. The rooms are empty and closed.

Acoustics

Sound insulation

by Wavin AS+

The excellent sound protection properties of Wavin AS+ are primarily attributed to its thick-walled design as well as special molecular structure and the high density of ~1.9 g/cm^3 of the material. This property enables Wavin AS+ to absorb airborne sound as well as mechanical vibrations.


Fraunhofer
IBP

Institution for testing, supervision and certification, officially recognized by the building supervisory authority. Approvals of new building materials, components and types of construction

Director
Prof. Dr. Philip Leistner
Prof. Dr. Klaus Peter Sedlbauer

Test Report P-BA 63/2019e

Determination of the Acoustic Performance of a Wastewater Installation System in the Laboratory according to EN 14366

Client: Wavin T&I
Rollepaal 20
7701 BS Dedemsvaart, Netherlands

Test object: Wastewater system "Wavin AS+, DN/OD 110 x 5.3, 05.11.2018" (manufacturer: Wavin). The wastewater system consisted of straight plastic pipes and fittings and pipe clamps "Wavin Low Noise bracket" with elastic inlay and spacers (manufactured by Walraven) mounted as sliding and fixing clamps.

Content:

Results sheet 1:	Summary of test results
Figures 1 to 3:	Detailed results
Figures 4 and 5:	Test set-up
Annex A:	Measurement set-up, noise excitation, acoustic parameters
Annex F:	Evaluation of measurements
Annex P:	Description of the test facility
Annex V:	Assessment according to VDI 4100

Test date: The measurement was carried out on April 17, 2019 in the test facilities of the Fraunhofer Institute for Building Physics in Stuttgart.

Stuttgart, May 14, 2019

Responsible Test Engineer: Dipl.-Ing.(FH) J. Mohr

Head of Laboratory: M.BP. Dipl.-Ing.(FH) S. Öhler

The test was carried out in a laboratory, accredited according to DIN EN ISO/IEC 17025:2005 by DAkkS. The accreditation certificate is D-PL-11140-11-01.

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A contribution to sound protection is made by the special product design and system solutions.

- Swept branches for minimal flow disturbance in the down pipe.
- Due to unique system bracket and high structure born sound prevention

Fig. 1: Double branch.

Fig. 2: Wavin System bracket.

In studies conducted at the Fraunhofer Institut für Bauphysik (Fraunhofer Institute for Building Physics), Stuttgart, Wavin AS+ has proven its excellent sound absorption properties. The tests were performed in a laboratory accredited by the German Accreditation System for Testing (DAP, file no. PL-3743.26) according to standard EN ISO/IEC 17025.

The measurements in this test were performed following German standard DIN EN14366 and DIN 52219:1993-07; noise excitation by stationary water flow with 0.5 l/s, 1.0 l/s, 2.0 l/s., 3.0 l/s and 4.0 l/s.

Noise calculation software

Determination of the sound level as conducted by Fraunhofer Institut Bauphysik is in general useful to determine the noise level of a pipe system in a static situation. The test method is, however, based on a laboratory set up in which all building parameters are kept the same except for a change in water flow. As a result it is impossible to obtain by this test a realistic figure of the noise levels for the protect chambers of actual projects.

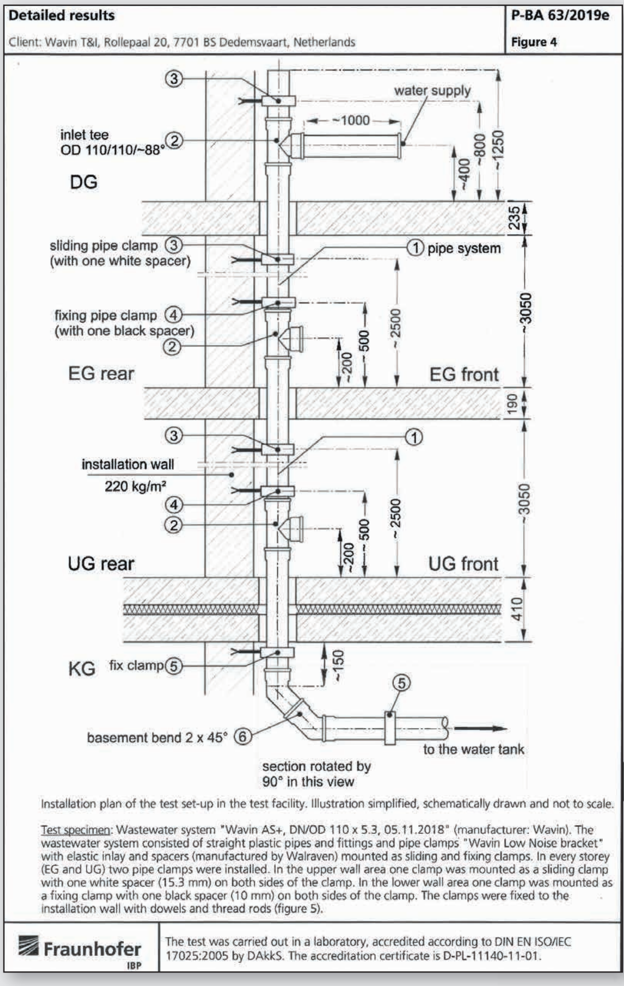
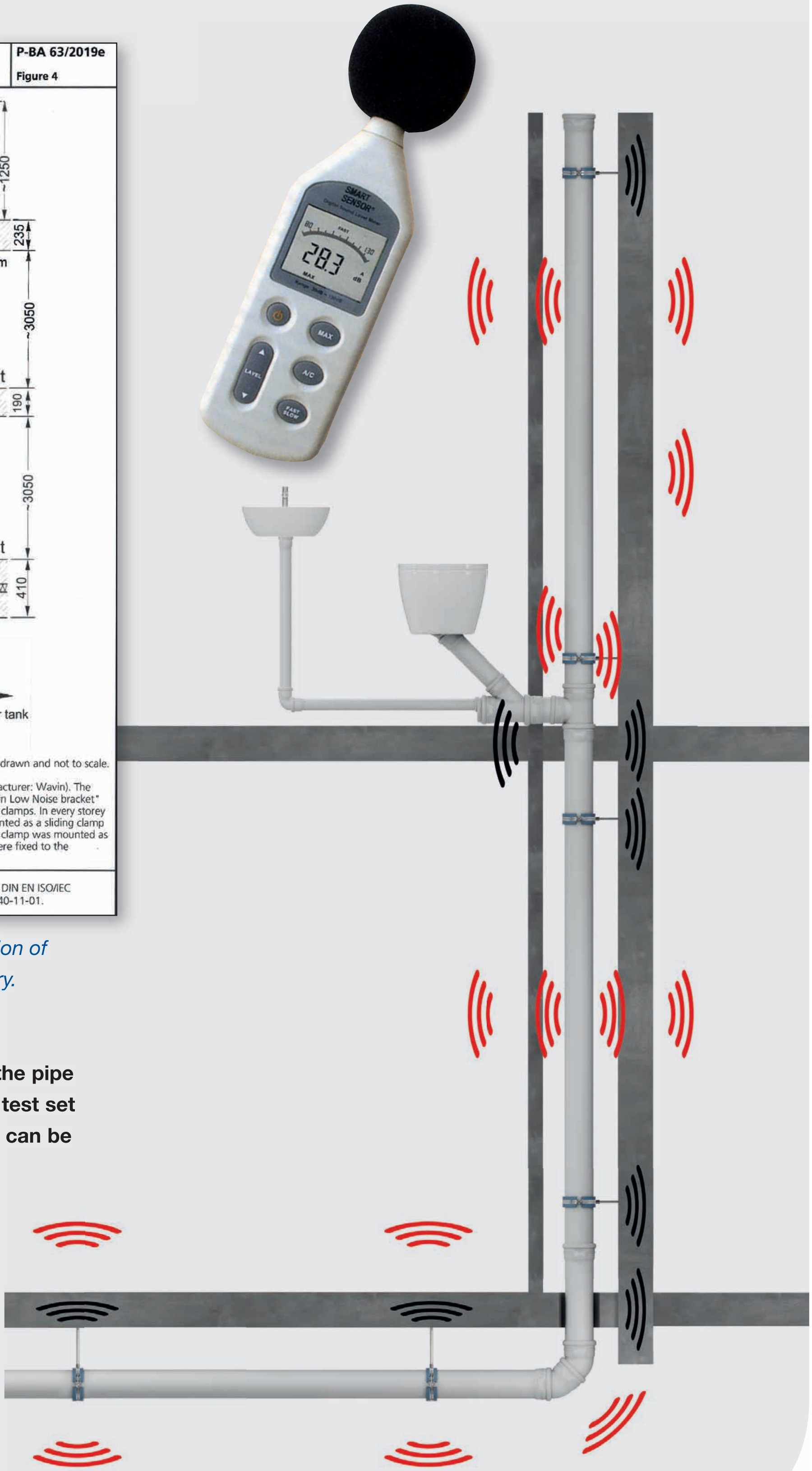


Fig. 3: FRAUNHOFER Test set up for determination of the installation sound level in the laboratory.



To actually determine real noise emission of the pipe system into a room requires a more dynamic test set up in which at least the following parameters can be modified.

- Pipe system characteristics
- Building design
- Shaft characteristics
- Suspended ceiling criteria
- Structural characteristics of the building
- Flow parameters
- Installation requirements
- Insulation requirements

Wavin SoundCheck tool

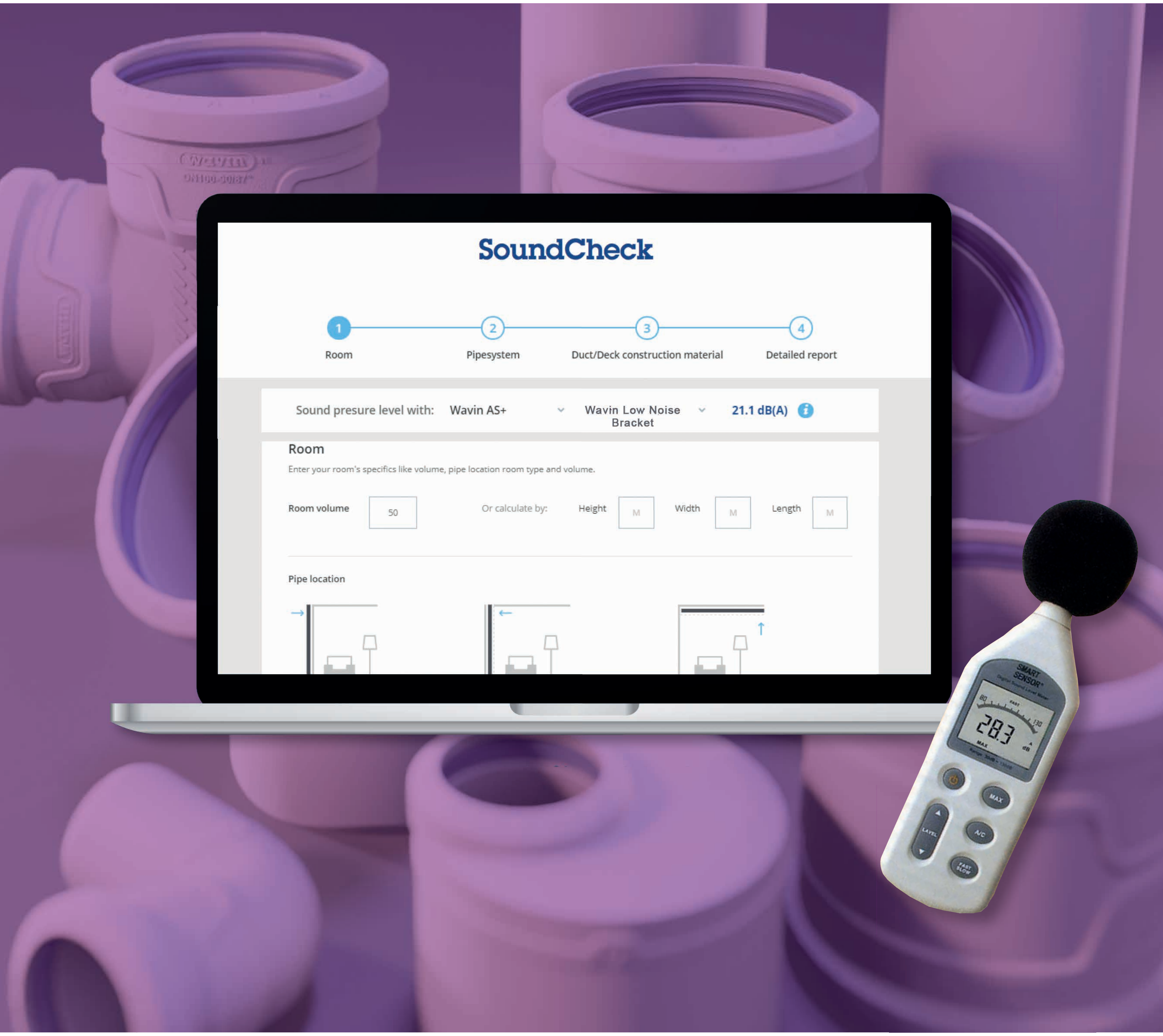
Calculating system acoustic just got easier

Wavin SoundCheck tool

Calculating system acoustic just got easier

With noise regulations continuously being updated, calculating noise levels to ensure your design meets requirements can be a complex exercise. Wavin's online SoundCheck Tool is designed to relieve some of that stress.

Unique to Wavin, the SoundCheck Tool simulates system acoustics in a final installation and calculates noise levels based on individual parameters. In just four clearly defined and intuitive steps, you can get the answers you need to see if your design meets regulations.



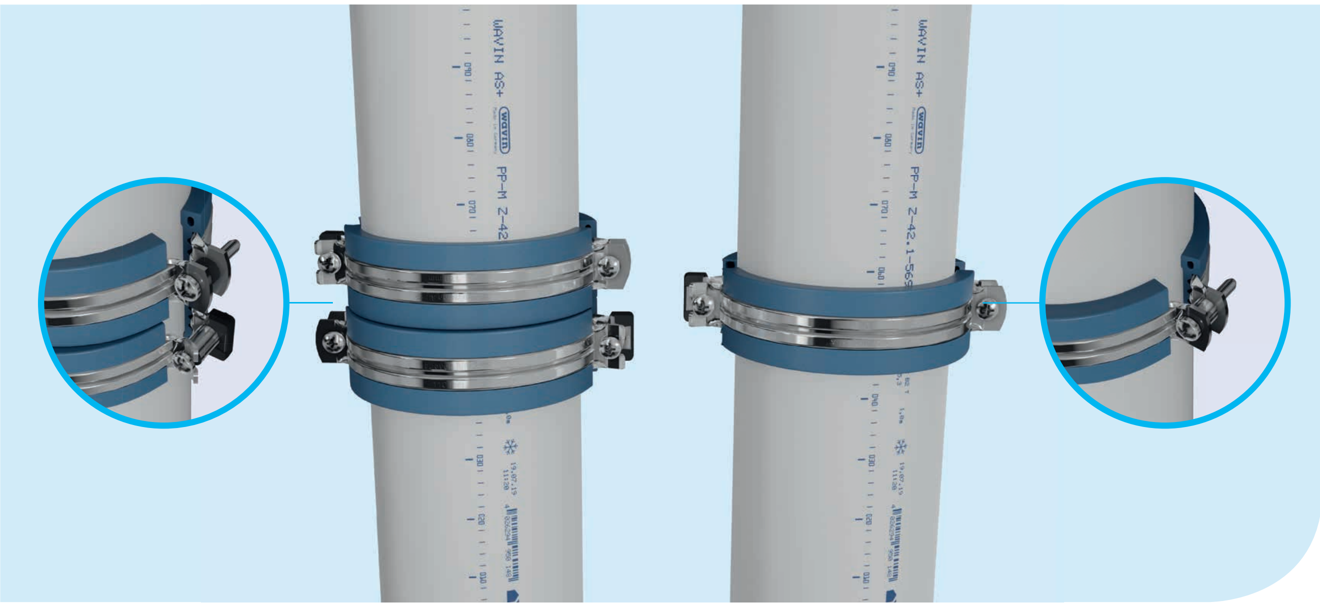
Sound-insulating performance

The excellent sound protection properties of Wavin AS+ are primarily attributed to its thick-walled design as well as special molecular structure and the high density of ~1.9 g/cm³ of the material used to make the pipes and fittings. This property enables Wavin AS+ to absorb airborne sound as well as structureborne sound.

Studies conducted at the Fraunhofer Institut für Bauphysik (Fraunhofer Institute for Building Physics), Stuttgart, on Wavin AS+ attest to its excellent sound absorption properties.

Wavin low noise bracket	**Volumetric flow rate***		**Meets standard**
	2 l/s	4 l/s	
DIN 4109 (public minimum legal requirement) specification 30dB(A)	14 dB(A)	19 dB(A)	✔
VDI 4100 sound insulation level II/III specification 27/24 dB(A)	11 dB(A)	16 dB(A)	✔
Installation noise level in rear basement (P-BA 63/2019)			
Wavin no noise bracket	**Volumetric flow rate**		**Meets standard**
	2 l/s	4 l/s	
DIN 4109 (public minimum legal requirement) specification 30dB(A)	<10 dB(A)	13 dB(A)	✔
VDI 4100 sound insulation level II/III specification 27/24 dB(A)	<10 dB(A)	10 dB(A)	✔
Installation noise level in rear basement (P-BA 64/2019)			

* Installation noise levels based on installation with Wavin system brackets.



With no noise
- *<10 dB(A) according to 64/2019.*

With low noise
- *14 dB(A) according to 63/2019.*

About Sound and Noise

About Sound

Sound is a sensation felt, a perception of what takes place around us, caused by various compression waves which cross the eardrum and are captured and transformed by the brain; it is composed of different frequencies. The acuteness or intensity of the perception depends on the frequency and range.

Sound is a wave that is:

- Elastic (it needs a medium to be propagated)
- Longitudinal (perturbation takes place parallel to the direction of propagation).

To exist it requires:

- A source (vibrating body)
- An elastic propagation medium (air, water, etc.)

A sound is therefore a method of transmitting mechanical energy. To propagate, a sound needs a medium: any means, whether solid, liquid or gassy, like air, is able to transport sound, influencing its speed according to density.

Sound is propagated through the exchange of air-solid-air or solid-air vibrations (in the second case the solid is the source of the sound). With respect to soundproofing soil and waste systems, we need to think in two different directions: (1) the noise created in the pipes and transmitted by them and (2) noise which is transmitted by the walls or surrounding media.

Sound is measured with a phonometer, an instrument which filters noise and measures intensity at its different frequencies. It is expressed in decibels.
The decibel is the logarithm of the ratio between the measured sound pressure and a reference sound pressure, multiplied by ten.

$dB = 10 \log (P/Pa)$

We need to remember that sound is an energy (just think of when you stand in front of the stereo speakers and you can “feel” the basses) but what we perceive is a processed sensation.

The human ear is sensitive to pressure in a NON LINEAR manner; therefore twice the pressure does not correspond to twice the sensation.

The doubling of acoustic power corresponds to an increase of 3 dB.

Every 10 dB increase is perceived by the human ear as twice as loud (10 cars are perceived as twice as loud as 1 car).

60 dB + 50 dB + 40 dB = 60.5 dB →
The highest dB is in a sum the most important

1 car = 60 dB

2 cars = 63 dB

10 cars of 60 dB = 70 dB
= twice as loud as 60 dB

Sound intensity follows an inverse square law with distance from the source; doubling the distance from a noise source reduces its intensity by a factor of four, or 6 dB.

Noise

Noise can be described as unwanted sound. In relation to sound, noise is not necessarily random.

Acoustic noise can be anything from quiet but annoying to loud and harmful causing permanent irreversible hearing damage.

Based on the World Health Organization (WHO) guidelines, European countries have maximized the noise level (in houses, apartments, hospitals, elderly homes, hotels, etc.) during the night to:

$L_{A\ max\ night}$ = 30 to 35 dB(A).

Community noise (also called environmental noise, residential noise or domestic noise) is defined as noise emitted from all sources except noise at the industrial workplace.

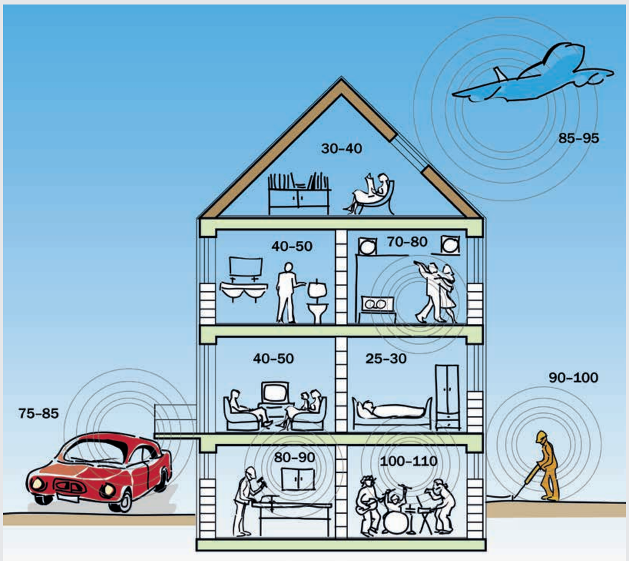


Fig. 4: Example of community noise.

In the European Union about 40% of the population is exposed to road traffic noise with an equivalent sound pressure level exceeding 55 dB(A) daytime, and 20% are exposed to levels exceeding 65 dB(A). When all transportation noise is considered, more than half of all European Union citizens is estimated to live in zones that do not ensure acoustical comfort to residents. At night, more than 30% are exposed to equivalent sound pressure levels exceeding 55 dB(A), which are disturbing to sleep. Noise pollution is also severe in cities of developing countries.

In contrast to many other environmental problems, noise pollution continues to grow and it is accompanied by an increasing number of complaints from people exposed to the noise. The growth in noise pollution is unsustainable because it involves direct, as well as cumulative, adverse health effects.

For instance sleep disturbance: measurable effects of noise on sleep begin at sound levels of about 30 dB. However, the more intense the background noise, the more disturbing is its effect on sleep. Sensitive groups mainly include the elderly, shift workers, people with physical or mental disorders and other individuals who have difficulty sleeping.

Table 1 presents the WHO guideline values arranged according to specific environments and critical health effects. The guideline values consider all identified adverse health effects for the specific environment. An adverse effect of noise refers to any temporary or long-term impairment of physical, psychological or social functioning that is associated with noise exposure. Specific noise limits have been set for each health effect, using the lowest noise level that produces an adverse health effect (i.e. the critical health effect).

Specific environment	Critical health effect(s)	L_{Aeq} [dB(A)]	Time base [hours]	L_{Amax} fast [dB]
Outdoor living area	Serious annoyance, daytime and evening Moderate annoyance, daytime and evening	55 50	16 16	- -
Dwelling, indoors Inside bedrooms	Speech intelligibility & moderate annoyance, daytime & evening Sleep disturbance, night-time	35 30	16 8	 45
Outside bedrooms	Sleep disturbance, window open (outdoor values)	45	8	60
School class rooms & pre-schools, indoors	Speech intelligibility, disturbance of information extraction, message communication	35	during class	-
Pre-school bedrooms, indoor	Sleep disturbance	30	sleeping-time	45
School, playground outdoor	Annoyance (external source)	55	during play	-
Hospital, ward rooms, indoors	Sleep disturbance, night-time Sleep disturbance, daytime and evenings	30 30	8 16	40 -
Hospitals, treatment rooms, indoors	Interference with rest and recovery	#1		
Industrial, commercial shopping and traffic areas, indoors and outdoors	Hearing impairment	70	24	110
Ceremonies, festivals and entertainment events	Hearing impairment (patrons:<5 times/year)	100	4	110
Public addresses, indoors and outdoors	Hearing impairment	85	1	110
Music and other sounds through headphones/ earphones	Hearing impairment (free-field value)	85 #4	1	110
Impulse sounds from toys, fireworks and firearms	Hearing impairment (adults) Hearing impairment (children)	- -	- -	140 #2 120 #2
Outdoors in parkland and conservations areas	Disruption of tranquillity	#3		

#1: As low as possible.
#2: Peak sound pressure (not LAF, max) measured 100 mm from the ear.
#3: Existing quiet outdoor areas should be preserved and the ratio of intruding noise to natural background sound should be kept low.
#4: Under headphones, adapted to free-field values.

Table 1: Guideline values for community noise in specific environments (Source World Health Organization).

About Sound

and how noise is measured

It is not enough to characterize the noise environment in terms of noise measures or indices based only on energy summation (e.g., LAeq), because different critical health effects require different descriptions.

It is equally important to display the maximum values of the noise fluctuations, preferably combined with a measure of the number of nerated by moving parts or by flowing media. Waste water discharge pipes are prone to vibration, particularly where water flows through downpipes, or is forced to change direction in joints and elbows (noise due to impact or shock). Experience shows that the greatest problems are typically caused by the transmission of structural noise, particularly in the area of pipe clamps and brackets or where pipe-work is run through walls or ceilings. The noise created from waste systems obviously depends greatly on the vertical piping. Here the falling water clashes against the wall of the pipes and fittings. The generated noise is transmitted directly to the pipes and indirectly through the ducts and installation walls. Therefore, the thickness and mass of the solid materials are of great importance, just like the fixing brackets and other elements which connect pipes to their supports.

How noise is measured

If we consider the "installation chamber" to be the room in which the pipes are installed (generally the bathroom), the room next door divided by the installation wall is called the "protected chamber". The noises emitted are measured in the protected chamber according to EN 14366.

Acoustic requirements

Local ruling increasingly describe the maximum acceptable sound level inside the living area of a building. Subsequently such noise limitation will then have to be established in contracts between the contractor and the awarding authority. The following technical regulations contain relevant advice and suggestions, which require a contractual agreement to become binding.

Fig. 5: Example of noise propagation during drainage.

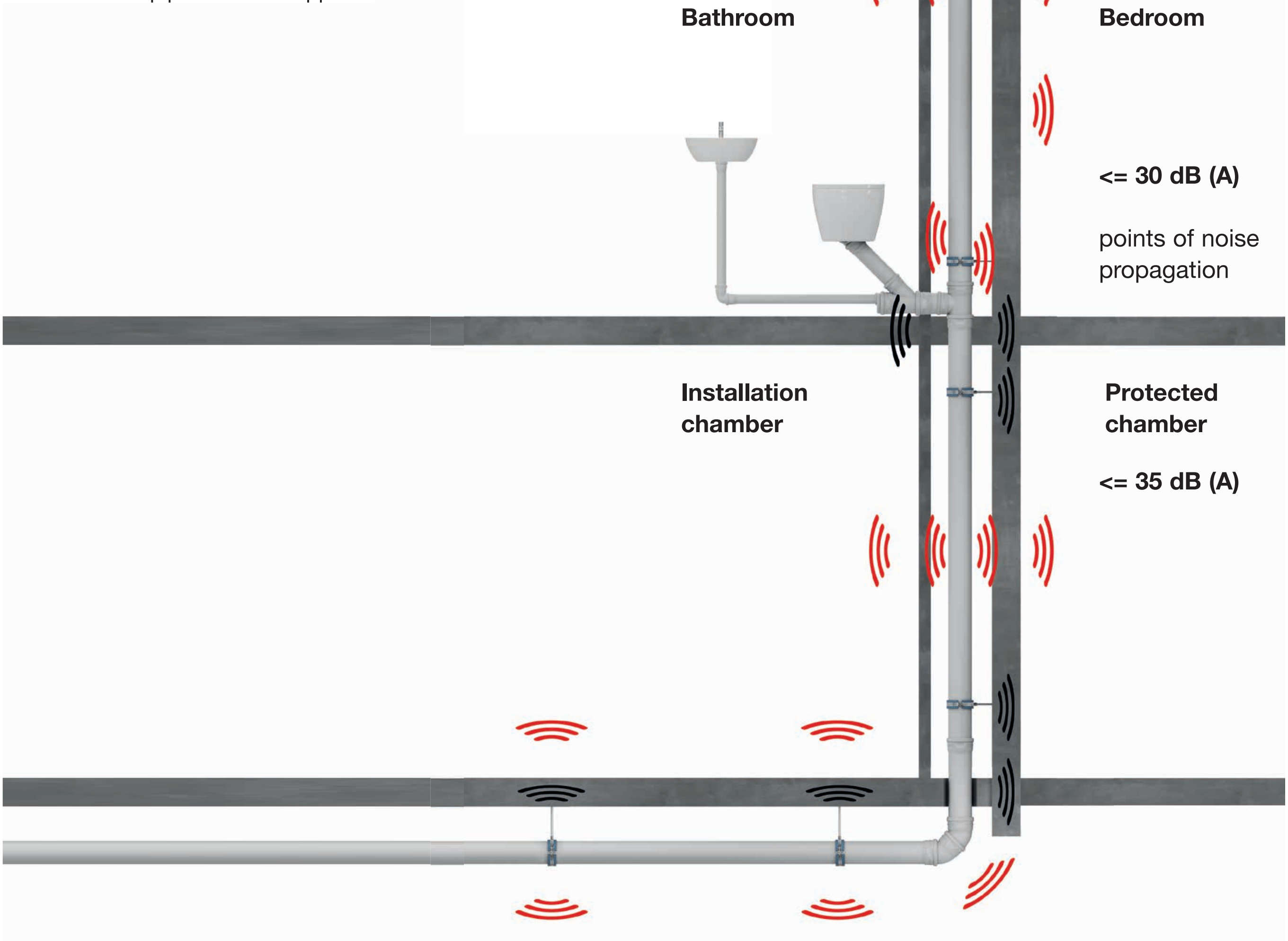
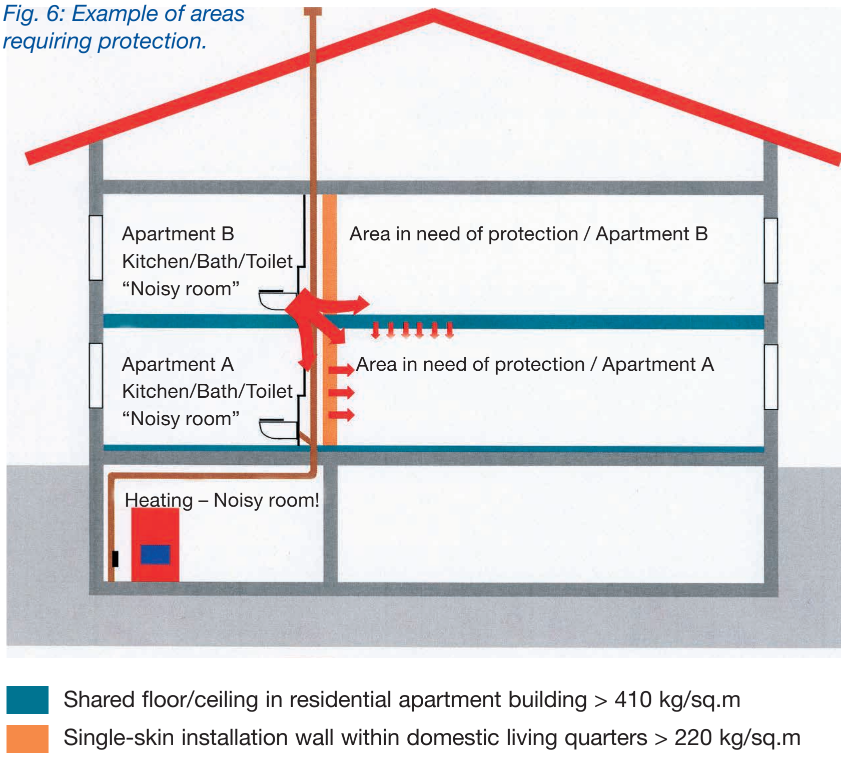


Fig. 6: Example of areas requiring protection.



DIN4109-5

This supplement contains instructions relating to noise levels that lie 5 dB (A) below the values given in DIN 4109-1:20/6-07.

In accordance with DIN 4109-5, increased levels of sound insulation can be arranged, by agreement, to a maximum of 25 dB (A) in other areas requiring noise protection.

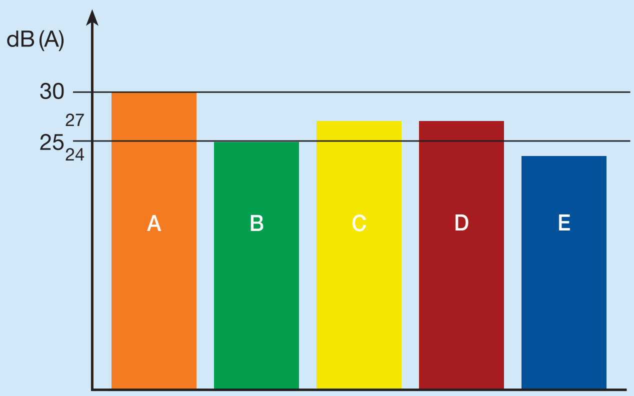
VDI 4100

In addition to the requirements of DIN 4109, which was adopted as Noise Protection Level I (NPL I), this guideline contains characteristic values for two additional noise protection levels – NPL II and NPL III.

These two additional noise protection levels specify the arrangements for increased sound insulation.

Fig. 7: Overview Noise Protection Standards and Guidelines.

A: DIN 4109 (minimum legal requirements)
B: DIN4109-5 Living rooms and bedrooms in apartment buildings
C: DIN 4109-5 Living rooms and bedrooms in single-family houses
D: VDI4100 Noise Protection Level II
E: VDI4100 Noise Protection Level III



Acoustic design

Advantageous layout
An important factor for the assurance of acoustic insulation is the design and implementation of an acoustically advantageous layout.

The following measures have proven to be of significant influence to the level of noise generated from the soil system inside the building:

- Noise-sensitive areas should be kept away, as far as possible, from sources of noise
- Non-sensitive areas should, wherever possible, be used as “buffer zones”
- Noise-sensitive areas should not be positioned in the direct vicinity of bathrooms, toilets or stairwells
- Potential sources of noise should be “bundled together” in the same area

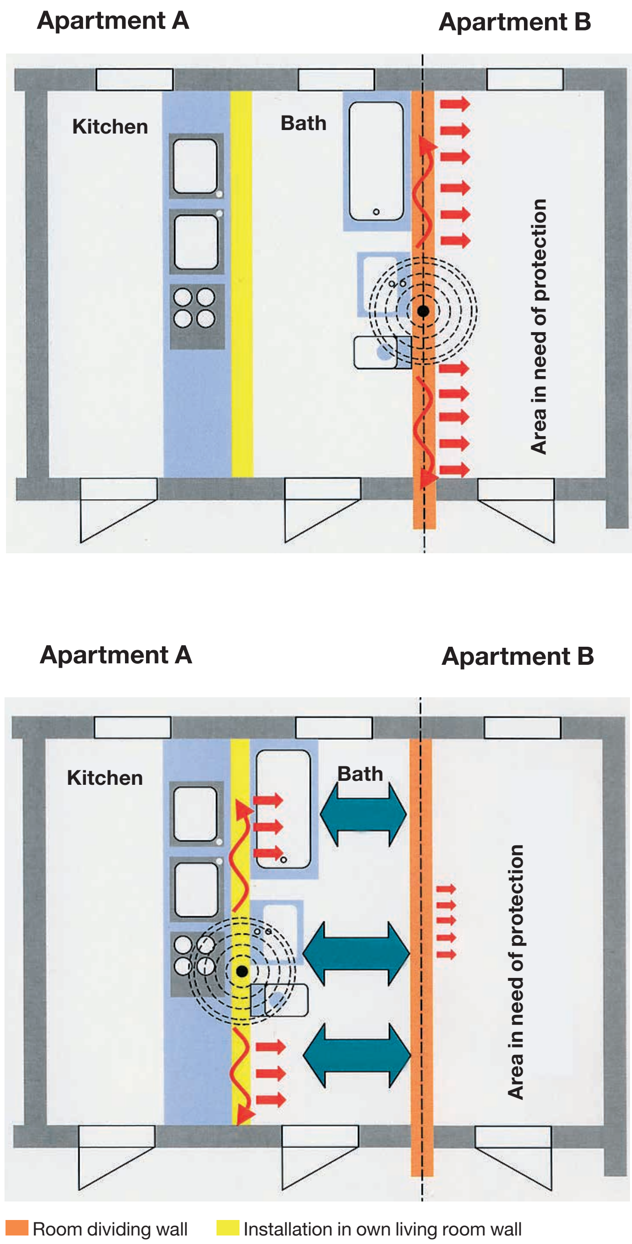
The comparison between the two examples of layout shown above demonstrates how the acoustically advantageous layout in the second example contributes to a clear reduction in the acoustic pressure of the systems in the room which demands acoustic insulation.

However, even using highly efficient low-noise waste systems like Wavin AS+, one always has to seek for the best possible acoustic decoupling. This goes for the whole drainage system and its points of contact with the building (collars, crossings through walls and floors, plaster residues between the pipe and the building, etc…).

In designing piping, moreover, we need to avoid positioning waste pipes in the partition walls between apartments. Special noise-reduction measures also need to be adopted when fixing drain pipes to the partition walls between apartments. Protect the pipes from the propagation of intrinsic noise.

The comparison of the floor plans above demonstrates how good acoustic design in the lower building example can significantly reduce the noise levels to which areas requiring noise protection are exposed.

Fig. 8: Examples of good acoustic practice in building design.



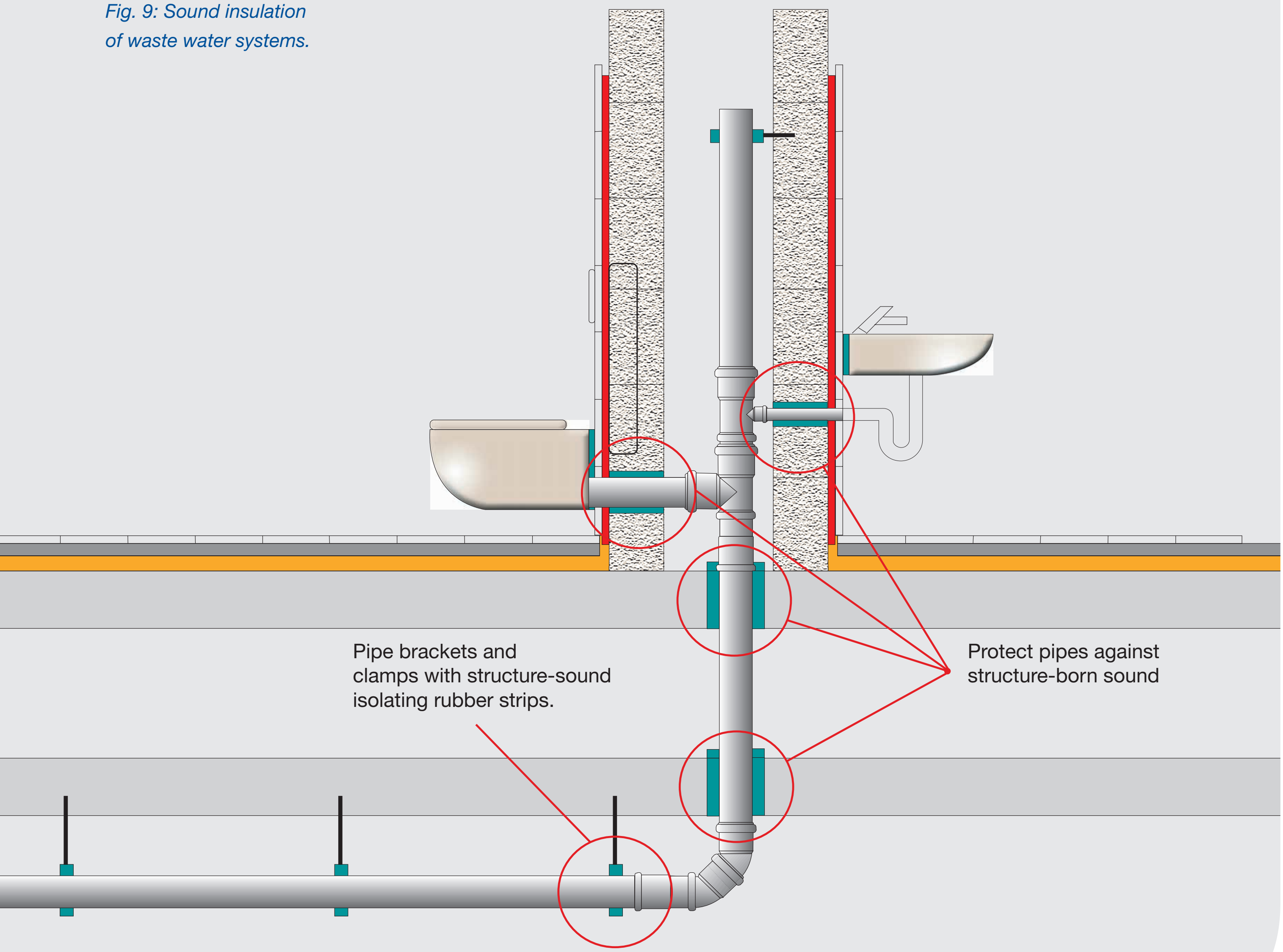
For further information on the full Wavin AS+ range visit: wavin.ie

Acoustic plumbing design

Wavin AS+ can significantly reduce noise levels when compared with other piping systems. However, when installing high-performance sound-insulating waste water piping systems it is still necessary to consider how effectively the system can be sound-isolated. This applies to the waste water discharge system as a whole, including its points of contact with the building structure (pipe brackets and clamps, the running of pipework through walls and ceilings, mortar droppings between pipes and wall surfaces, etc.).

When planning pipe installation, waste water discharge pipes should not be allowed to run inside the walls separating living areas. The attachment of waste water discharge pipes to partition walls in living areas should only be carried out under application of special noise protection measures. DIN 4109 requires that single-skin walls to which, or in which, water installations or equipment (i.e. waste water pipes) are to be attached must have an area-related mass of at least 220 kg/sq.m. Walls having an area-related mass of less than 220 kg/sq.m may only be used where prior testing has demonstrated that the walls exhibit acceptable properties with respect to the transmission of noise.

Fig. 9: Sound insulation of waste water systems.



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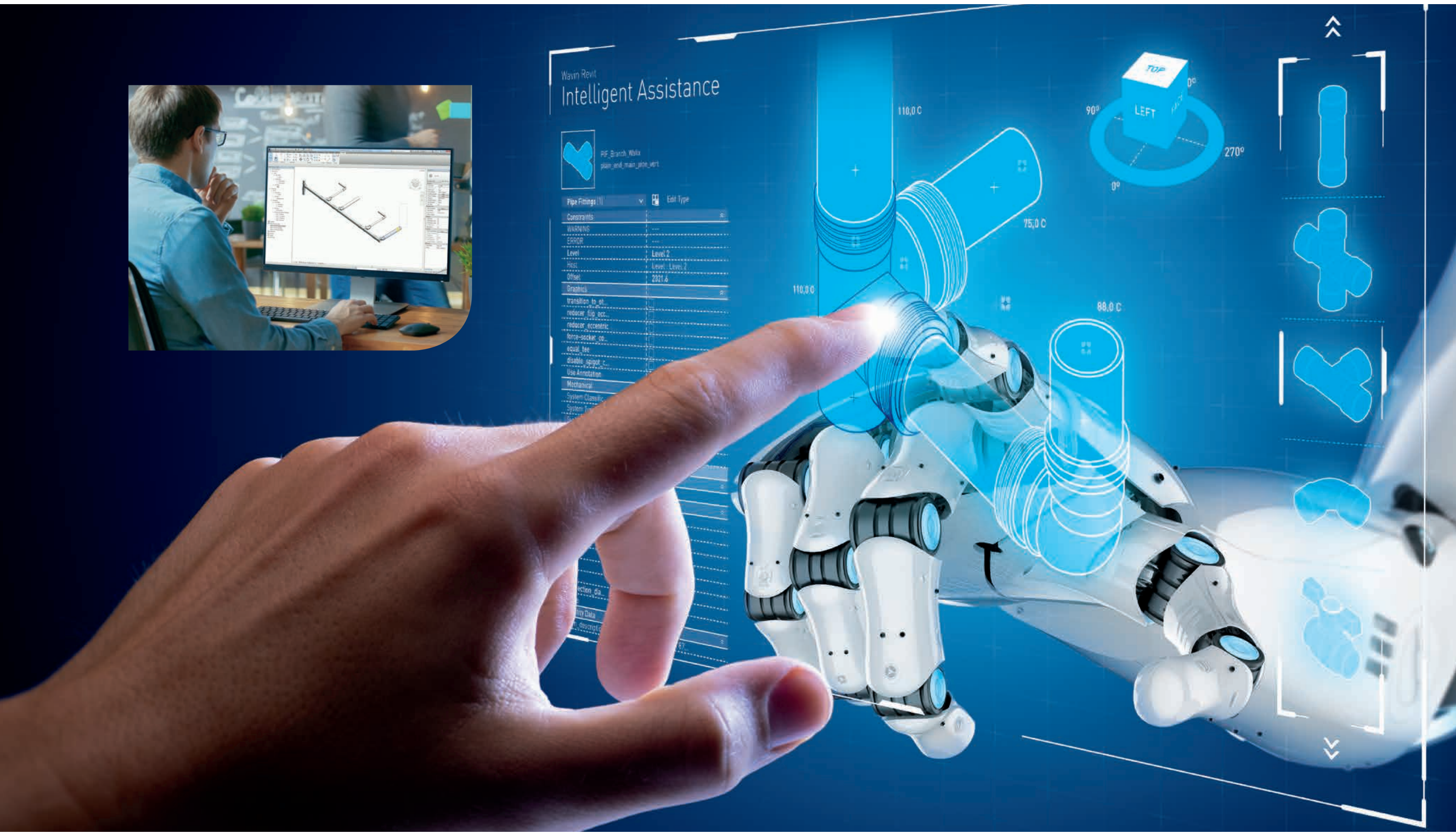

From system design to site

In-built intelligent assistance makes our BIM solution simply the best and our Revit packages are the first and only ones in the UK to be awarded the BSI Kitemark for BIM Objects. As a result, you will have access to all the economies, speed and 100% accurate digitalised modelling with BIM design from Wavin.

Intelligent assistance automates key aspects of pipe system design to speed the creation of fully detailed 'as-built' models. This right first time solution will provide significantly reduce installation time and deliver real savings on-site.

Intelligent assistance virtually designs the system for you

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