MANAGING SOUND TRANSMISSION INSIDE BUILDINGS

Guidance Notes

British Plastics Federation
PIPES GROUP

MANAGING SOUND TRANSMISSION INSIDE BUILDINGS

Introduction

Noise from wastewater flow when it travels around a building can be an annoyance. This is unpleasant in detached family homes but particularly intrusive in multi-occupancy residential and commercial properties.

Example of buildings where sound attenuation is often specified:

- Shared dwellings
- Multi-storey apartments
- Hotels
- Hospitals and care facilities
- Office buildings
- Schools and universities
- Retail outlets

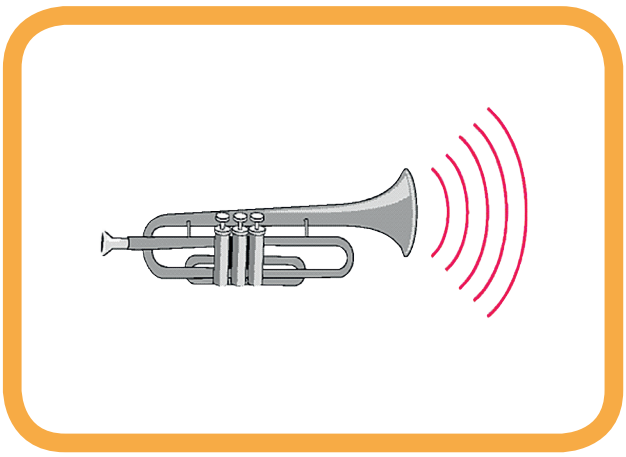
As noise continues to increase inherently from our 24/7 lives, clients and specifiers are seeking to minimise avoidable noise by soundproofing buildings. The ability to engineer plastic pipes through material and construction choices means that they can be designed to absorb both air-borne and structure-borne sound. This makes them ideally suited to the transport of water and waste water through a building.

This guide provides information on design and installation of plastic piping systems for drainage inside buildings intended to manage sound transmission.

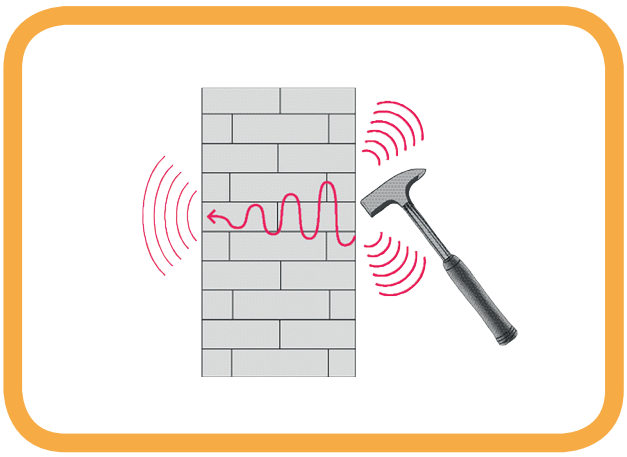
Sound transmission in buildings

Source and transmission

Every object in motion makes noise, transmitting its vibrations in the form of pressure or negative pressure waves, to the surrounding air. Inside a property this might result from conversations, media, movement, appliances and so on. Noise can be transferred through the air (air-borne) or through the building fabric (structure-borne).



Air-borne noise



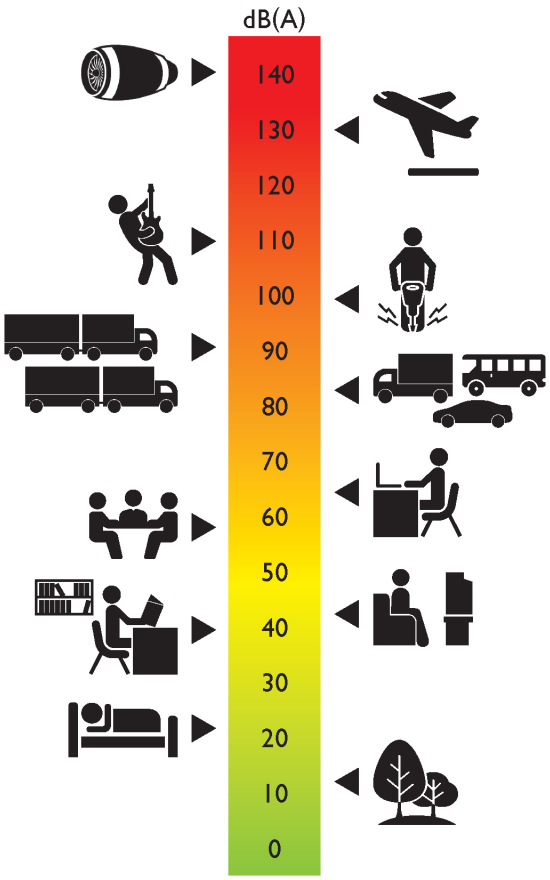
Structure-borne noise

A person's sensitivity to noise, when above the hearing threshold, will depend on the source and the location. For example, the acceptable sound level at a rock concert which you have chosen to attend is very different to the level tolerated when trying to sleep in a noisy hotel or relaxing in a quiet country location.

Maximum acceptable noise in buildings

The recommended maximum sound levels in residential buildings vary by country, with an **absolute sound pressure level** of 30dB(A) being generally accepted as the maximum in rooms requiring sound insulation, for example living rooms and bedrooms. This absolute value is measured against a fixed reference point (i.e. threshold of hearing) and takes into account all noise from building services including waste water running through pipes. However, a range of requirements may be seen across projects as the value is not well defined. As buildings become quieter due to improvements in insulation products and practice, so the noise from building services is more noticeable and the requirements for noise reduction more stringent.

In the UK, the Building Regulations (2010) Approved Document E "Resistance to the passage of sound"[1] specifies a **noise reduction** rather than an absolute value. It stipulates that any wall or floor should reduce the noise transmitted to the next room by 45dB(A) or more. Unlike the absolute value above, the reduction in noise is based on building design including the lagging of soil and waste pipes, but excluding noise from waste water running through pipes. This applies to any kind of building used as a dwelling, including houses and apartments and rooms for residential purposes such as accommodation for students and nurses, care homes, hotels etc.



[1] Available from https://www.gov.uk/government/publications/resistance-to-sound-approved-document-e

Illustration of noise levels from a range of activities

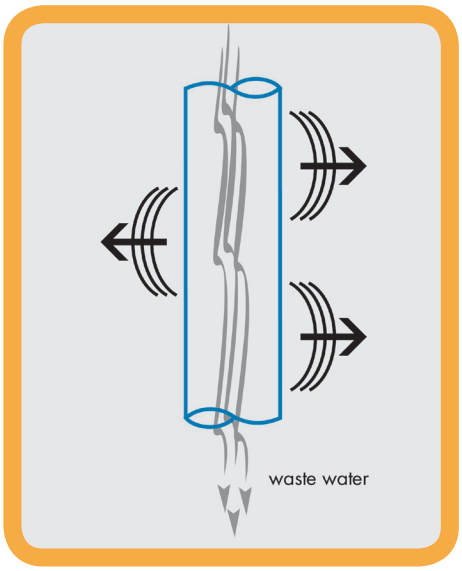
A summary of recommendations across England and Wales, Scotland and Northern Ireland can be found in NHBC factsheet "Acoustics factsheet: Requirements for new homes and how NHBC can help." Additional guidance is provided in BS 8233 "Guide on sound reduction in buildings" which sets out the maximum acceptable noise levels by room such as *not to cause a disturbance to users.*

Contribution of soil and waste pipe systems to noise

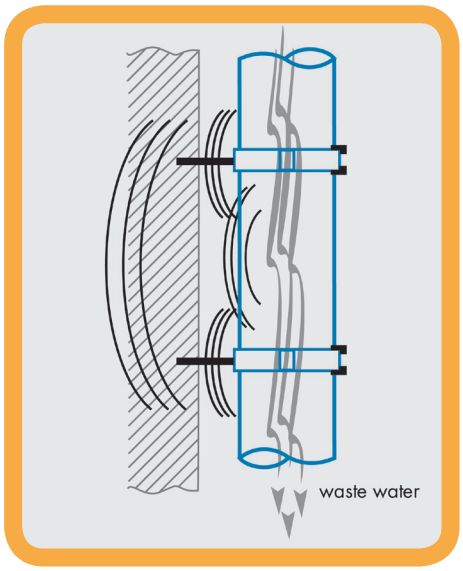
Noise from waste water

Soil and waste systems inside buildings have the potential to contribute to noises inside a property and to an adjoining property.

- Air-borne noise – generated by waste water flowing inside the pipes.
- Structure-borne noise – generated by vibration (acoustic resonance) of the pipe as the sound waves generated by the waste water moving through it impinge on the pipe walls and in turn are transmitted through pipe clips and brackets to the building structure.



Air-borne noise



Structure-borne noise

Both sources of noise can be managed by good system design, product choice and correct installation.

Traditional approach to soundproofing soil and waste systems

All sanitary pipework should be designed in accordance with BS EN 12056-1 "Gravity drainage systems inside buildings - general and performance requirements" and BS EN 12056-2 "Gravity drainage systems inside buildings - sanitary pipework, layout and calculation." This standard applies to dwellings, commercial, industrial and institutional buildings. However, on the subject of noise, this standard requires only that consideration is taken in design and installation and refers to national and local practice.

The traditional approach to reducing sound transmission is the use of pipe wrapping materials, typically mineral wool to absorb the sound. Pipes are enclosed for their full height. Approved Document E gives little information as to how this should be achieved in a practical manner. The NHBC factsheet does not address pipework.

The traditional approach is highly dependent upon secondary action to wrap the pipe after installation, making good entries to walls and floors, and the appropriate use of brackets and insulating pads.

The modern approach - "quiet" soil and waste systems

Sound-attenuated plastic pipe, together with purpose-designed ancillaries such as flexible and vibration-resistant joints, support clips and fire collars provide a more modern approach to the design of soil and waste systems.

Reducing air-borne noise - the sound attenuated pipe should limit the propagation of air-borne noise and keep it inside the pipes. Pipes are manufactured from PVC-U, PP or PE. They may be filled with sound-dampening minerals which increase the density of the pipe to slow the transmission of noise and constructed in multiple layers to reflect sound waves at layer boundaries.

Reducing structure-borne noise - the best acoustic performance is achieved by preventing structure-borne sound. Good design is important . Acoustically engineered fittings designed to allow expansion in the pipework, fully encircling supporting and sliding clips with rubber inserts which insulate the system, and cushioning of the pipework through concrete floors ensure that transmission of the acoustic resonance is reduced to the minimum.

Known as sound-attenuated, low noise, or acoustic systems, the right combination of pipes and ancillaries can offer either: (a) a sound insulated discharge (soil) stack with connections from the branch pipework inside the property; or (b) a sound insulated soil stack and sound insulated branch pipework to sanitary appliances.

When installing these pipe systems, many operations are the same as best practice for all plastic soil pipes - for example pipe handling and cutting, preparation of pipe ends for jointing, installation of multiple entry boss connectors and strap-on bosses for branch connections, clipping distances.

Whilst good practice in installation is always important, the use of a complete pipe system designed specifically to manage noise inside buildings offers many benefits.

Reliable results

Less reliance on secondary actions such as lagging being completed.

Speed of installation

Less time on site needed for lagging and making good wall and floor penetrations.

Pipe performance

Pipes meet the mechanical requirements of European Standards for soil and waste pipe, with good chemical resistance (pH 2 - 12); resistance to high temperatures and impact at low temperatures.

Weight of pipe

Pipes with mineral fillers or multiple layers are heavy enough to provide good sound absorption but still significantly lighter than iron pipes used for soil stacks.

Ease of installation

Pipes, fittings and fixings designed to be compatible.

Acoustic performance

Complete systems offer the opportunity for better sound insulation than a lagged single-wall, plastic soil system.

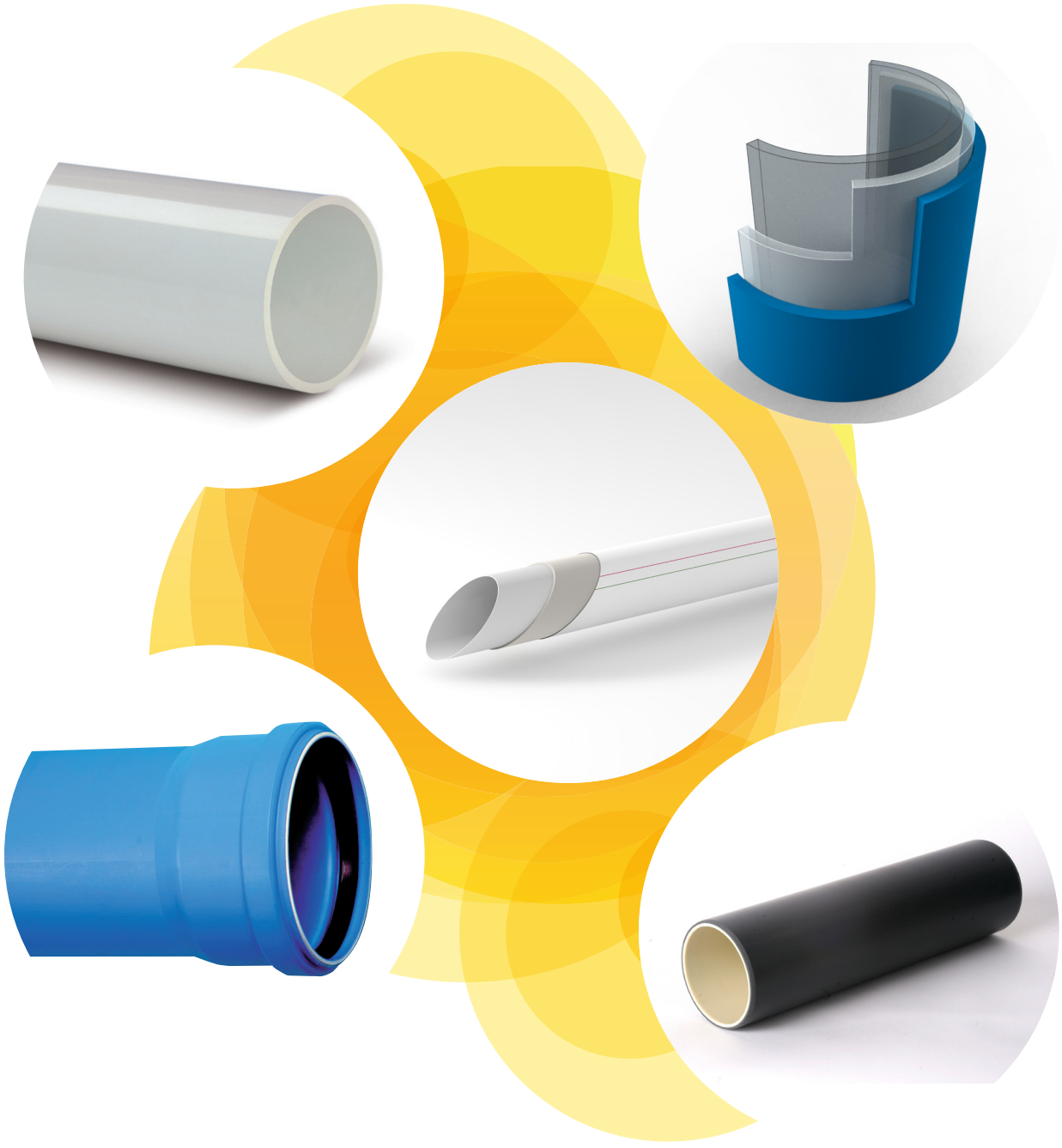
To achieve the optimum acoustic performance from pipe systems designed to manage sound transmission in building, this guide provides specific advice on choosing a pipe system and understanding test results from acoustic testing.

Products

Pipe design and construction

Manufacturers of acoustic pipes employ two key techniques to absorb sound and minimise transmission through the pipe:

- Increased mass through use of thicker walled or layered pipe - sound travels in waves and can be reflected in the same way as light. The layer boundaries help to reflect the sound waves created in the pipe by the flowing waste water. The sound is absorbed by the pipe mass.
- Use of denser materials - sound waves travel more slowly (dampened) in denser materials. Using mineral fillers in the pipe wall or one of the layers in the pipe wall helps the absorption of sound.



Product standards

There are currently no British or European Standards which address acoustic performance. However, pipes and systems are designed to meet mechanical performance requirements consistent with solid wall pipes or structured wall pipes used for soil and waste discharge inside buildings. These are:

- BS EN 1519-1: 2000 Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Polyethylene (PE). Specifications for pipes, fittings and the system.
- BS EN 1451-1: Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Polypropylene (PP). Specifications for pipes, fittings and the system.
- BS EN 1329-1: Plastics piping systems for soil and waste discharge (low and high temperature) within the building structure. Unplasticized poly(vinyl chloride) (PVC-U). Specifications for pipes, fittings and the system.
- BS EN 1453-1: Plastics piping systems with structured-wall pipes for soil and waste discharge (low and high temperature) inside buildings. Unplasticized poly (vinyl chloride) (PVC-U). Specifications for pipes and the system.

As acoustic pipe systems use innovative manufacturing techniques to achieve enhanced levels of noise attenuation, some systems may not conform exactly to the current manufacturing standards above. For instance, pipe may be manufactured with a different wall thickness or utilise multi-layer technologies which sit outside the scope of existing standards. If this is the case, it is recommended that specifiers and installers check with the manufacturer to ensure that appropriate mechanical performance testing has taken place. More specifically, it is recommended that the system performs to a level consistent at least with the standard for the relevant above ground systems listed above.

BPF Pipes Group members supplying plastic piping systems for soil and waste discharge to these standards include guidance in their technical brochures https://bpfpipesgroup.com/applications/building-services/

Ancillaries

As for pipes, there are no standards which specifically address the acoustic performance of fittings or fixings.

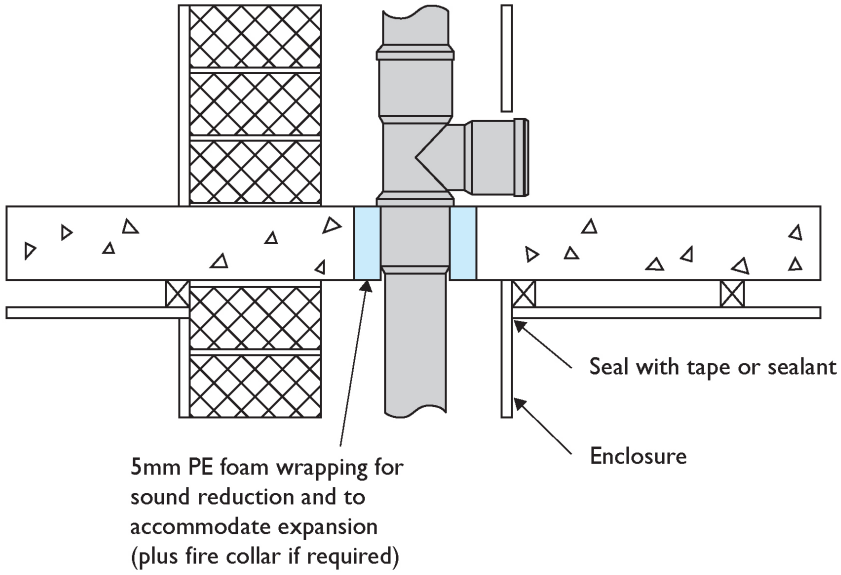
Joints: Pipes are typically joined by an integral push-fit socket on one end of the pipe, a push-fit connection to plain ended pipes, or heat welding. They may incorporate specific features such as increased wall thickness to help sound insulation and an expansion compensator to enable thermal movement of the pipe to be accommodated.

Brackets: Pipes are secured to the building using brackets or clips. These clips are designed to fully enclose the vertical stack or branch pipe holding it securely and away from any batons or plasterboard. They typically incorporate a rubber or polymer insert to insulate the system from structure-borne sound.

The connections and clips are designed and tested as a complete system with the manufacturer's pipe and should always be used together.

Fire collars: Where any soil pipe passes through walls, floors or ceiling and bridges fire compartments, passive fire protection measures may be necessary. This can be achieved by the installation of fire stop collars. This measure is not exclusive to acoustic pipes but, as with connections and clips, collars need to be tested on the pipe for which they are intended and used together. A fire collar may be combined with a pipe jacket, providing the fire test has been completed on the combined system.

Pipe Jackets: Where any soil pipe passes through walls, floors or ceiling and does not require fire protection measures, a 5mm PE foam sound insulator can be wrapped around the pipe to prevent sound vibrations travelling from the pipe to the concrete as it passes through a floor or ceiling.



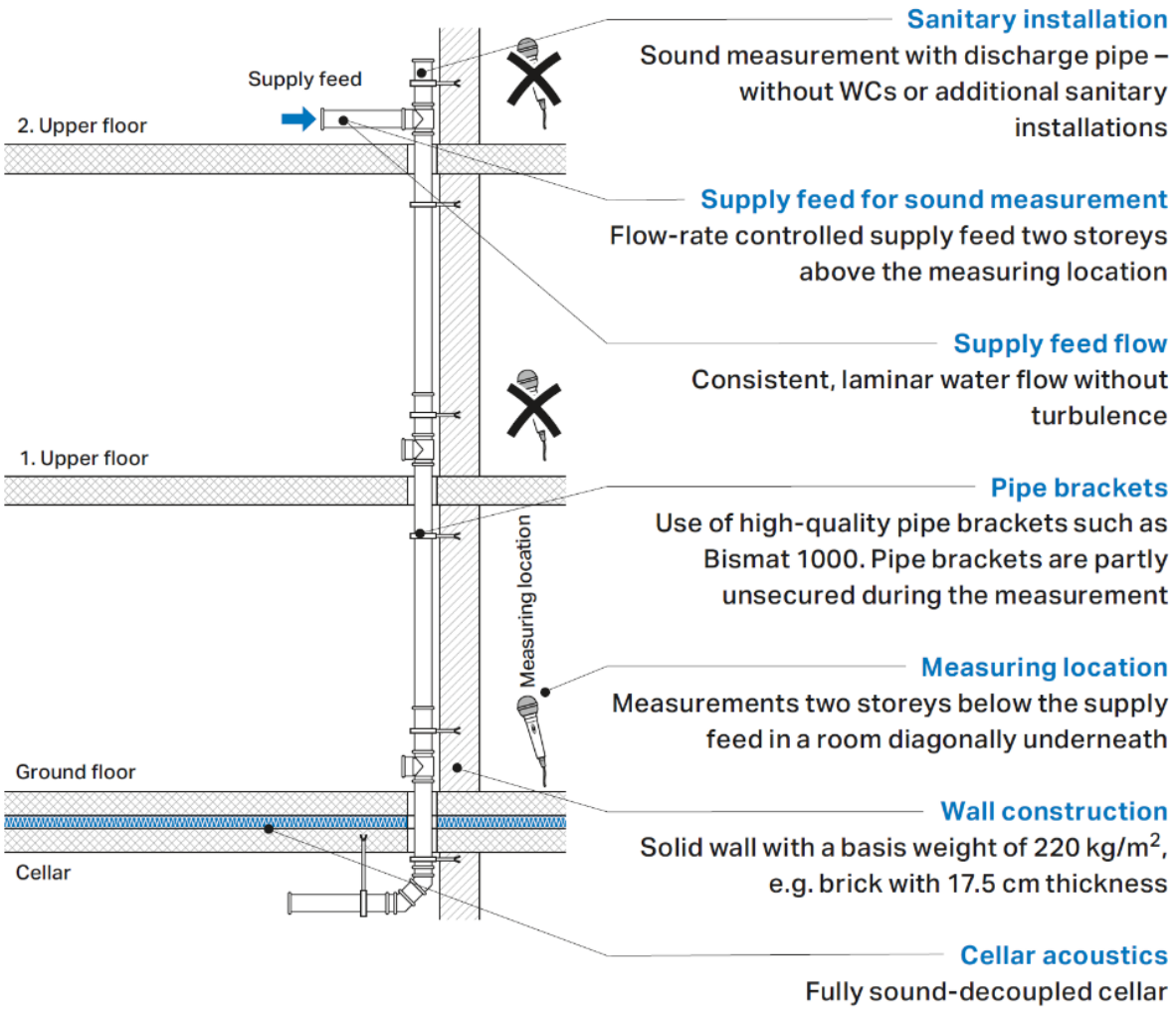
Acoustic testing

Most independent testing in the UK has been carried out by the Fraunhofer Institute for Building Physics (IBP) in Stuttgart, Germany to the standard BS EN 14366 "Laboratory measurement of noise from waste water installations."

BS EN 14366 establishes methods for measuring sound arising from waste water installations under laboratory conditions. Whilst this is a large-scale test set-up which reflects a waste water system inside a building, it is a single set-up to allow comparison of products, materials and system components and will not reflect the details for any individual project.

The first test conducted gives the value for installation sound pressure levels generated for the system as installed in the test set-up. This value is the contribution of the waste water running through the pipes towards the overall noise from the building services.

Using a series of test configurations, frequency spectra for air-borne and structure-borne sound are determined individually to help the acoustic consultant address specific requirements for the building.



IBP report notation for location: Cellar = KG; Ground floor = UG; 1. Upper floor = EG; 2. Upper floor = DG.

Choosing a plastic piping system to manage sound transmission?

What do I need to check in the test report?

- The test set-up matches the installation guidance provided by the manufacturer.
- The pipes and brackets used in the test match the available product range.
- The sound levels and sound level / frequency graphs are measured and presented at the ground floor UG (see schematic).
- Two installation sound level values may be shown - one calculated using DIN 4109 and one calculated using VDI 4100. These are a first indicator of the sound-attenuation capabilities of the pipe system. When comparing values, it is important to consider 'like with like'.
- The full report is available showing the frequency spectra for the structure-borne and air-borne for use by the acoustic consultant.

What do the results mean?

- The results apply to the combination of wastewater pipe and pipe clamp in the test set-up.
- The installation sound level following DIN 4109 or VDI 4100 is a first indicator and for sound-attenuated plastic pipes might be 20 dB at 4 l/s waste water flow and 15 dB at 2 l/s waste water flow.
- The frequency spectra for structure-borne and air-borne sound can be used by the acoustic consultant with BS EN 12354-5 "Building acoustics. Estimation of acoustic performance of building from the performance of elements. Sounds levels due to the service equipment".
- By considering additional values (for example, the noise of other building services such as WC facilities, shower areas, bathtubs, etc.), the results can be used to estimate the noise in different building situations.

Can I compare piping systems?

In 2016, the Fraunhofer Institute (IBP) issued a statement recognising difficulties in reproducing test results which are highly dependent on the installation techniques employed. Improvements to the test programme were made as a result. IBP has recommended that data produced prior to 2014 should not be used.

Data produced for pipes in a specific sanitary design provides a realistic expectation of what can be expected from that installation in a real building. However, it is also influenced by other aspects of the sanitary design such as WC design, location, floor and wall construction etc. So, at present, there is no easy way to compare one pipe system with another unless tested in the same configuration.

It is recommended that the data from a suitably configured 'real' installation is compared to the requirement for the building on a project-by-project basis.

It is possible to perform 'building mock-up tests' whereby wastewater systems can be tested in the test facilities used for BS EN 14366 under practical conditions to evaluate different sanitary installations. The results of mock-up tests can be compared directly with sound insulation requirements for the specific project.

Delivering optimum acoustic performance

System design

Design of all sanitary pipework should be carried out in accordance with EN 12056 Parts 1, 2 and 5 which covers all aspects of sanitary pipework design and installation.

To improve the acoustic performance of the drainage system, the system design should seek to minimise turbulence and also the creation of bubbles which impact on the pipe wall. Take care with the following:

- Optimise the flow of wastewater - use smooth wall pipes.
- Avoid sudden changes in speed of wastewater i.e. rapid changes in pipe diameter.
- Avoid abrupt changes in direction to promote free flow - this can be achieved in the change from vertical to horizontal by using 2 x 45° long bends, creating a 250mm long 'resting' or 'cushioning area.
- Where sound-dampening brackets are used on horizontal lines, these need to allow for horizontal movement.
- Use sound-absorbing / dampening brackets which are dimensionally compatible with the acoustic pipe. These are full circle brackets with rubber inserts which insulate the system from structure-borne sound. (Note: Insert strips of soft PVC are not acceptable).
- Use the bracket for the system supplied by purchaser - don't forget to check back to the results of the BS EN 13466 test report.
- Avoid contact between the soil stack and the plaster layer which may create sound bridges. Where contact with the wall cannot be avoided, a layer of mineral wool or 5mm PE foam should be wrapped around the pipe.
- Avoid contact between the pipe and the building structure i.e. floor / wall / ceiling by installing an insulation layer (typically 5mm PE foam insulator) in the penetration hole before 'making good' the hole.
- Avoid contact between fire collars and the building structure.

Specifying an acoustic system

When specifying a system to manage sound transmission in buildings, take care with the following:

- All components are from a system tested and supplied by one manufacturer.
- The full test report to the standard BS EN 14366 is provided for use by the acoustic consultant.
- Depending on acoustic specification of building, additional measures detailed e.g. mineral wool.
- Fire collars tested with acoustic pipe system.
- Appropriate installation guidance for manufacturer's system to be provided.

A list of members who manufacture and supply plastic pipes for acoustic pipes for domestic properties is provided on the BPF Pipes Group website,

https://bpfpipesgroup.com/applications/building-services/