Fraunhofer
IBP

Test Report P-BA 316/2014e

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. Klaus Peter Sedlbauer

Noise behaviour of an insulating tube for wastewater installation systems

Client: ROLS ISOMARKET
Vyatskaya str. 27
127015 Moscow

Test object: Structure-borne sound insulating tube for wastewater installation systems "ENERGOFLEX ACOUSTIC", manufacturer: Rols Isomarket, in combination with a wastewater system consisting of plastic pipes (HT, OD 110).

Content:

Test date: The measurement was carried out on 21 November 2014 in the test facilities of the Fraunhofer Institute for Building Physics in Stuttgart.

Stuttgart, 17 December 2014

Responsible Test Engineer:	Head of Laboratory:
	i.V.
M.BP. Dipl.-Ing.(FH) S. Öhler	M.BP. Dipl.-Ing.(FH) S. Öhler

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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.

Fraunhofer-Institut für Bauphysik
Nobelstraße 12 · D-70569 Stuttgart
Telefon +49 (0) 711/970-00
Telefax +49 (0) 711/970-3395
www.ibp.fraunhofer.de

Prüfstelle Bauakustik und Schallimmissionsschutz
Nobelstraße 12 D-70569 Stuttgart
Telefon +49(0) 711/970-3314; Fax -3406
akustik@ipb.fraunhofer.de
www.ibp.fraunhofer.de/de/pruefstellen/bauakustik.html

ilac-MRA DAkkS Deutsche Akkreditierungsstelle D-PL-11140-11-01

Determination of Installation Sound Level L_{In} and the insertion loss D_e in the Laboratory	P-BA 316/2014e Results sheet 1

Client: ROLS ISOMARKET, Vyatskaya str. 27, 127015 Moscow

Test specimen: Structure-borne sound insulating tube for wastewater installation systems "ENERGOFLEX ACOUSTIC" manufacturer: Rols Isomarket, in combination with a wastewater system consisting of plastic pipes (OD 110).
(test object no.: 10748-1; figure 4)

Test set-up: Insulating tube "ENERGOFLEX ACOUSTIC", Rols Isomarket for straight pipes, made of closed-cell polyethylene-based foam material for covering wastewater installation systems. Dimensions: inner diameter ca. 180 mm, wall thickness (inner surface profiled) ca. 12/6 mm.
Measurement set-up (according to figure 4):
A Commercial wastewater system consisting of plastic pipes and fittings (HT, OD 110), wall thickness 2.7 mm, weight 0.92 kg/m, density 0.95 kg/dm³ (straight pipes, three inlet tees, a 88°-basement bend and a horizontal drain section. The inlet tees in the basement and in the ground floor were closed by lids) was installed in the installation test facility P12. The pipe was completely poured by mortar in the opening in the ceiling between the installation rooms EG front and UG front.

- Test set-up: Wastewater system with insulating tube "ENERGOFLEX ACOUSTIC", Rols Isomarket.
  Pipe poured in the opening of the ceiling with pipe covering (without pipe clamps or other fastening parts).
- Reference set-up: Rigid installation of the wastewater system.
  Pipe poured in the opening of the ceiling without pipe covering.

The Installation was conducted by a handicraft enterprise ordered by IBP.

Test facility: Installation test facility P12, mass per unit area of the installation wall: 220 kg/m², mass per unit area of the ceiling: 440 kg/m². Installation rooms: top floor (DG), ground floor (EG) front, basement (UG) front and sub-basement (KG); measuring room: basement (UG) rear. (For further details, please refer to Annex P.)

Test method: The measurements were performed following DIN 4109 and DIN EN 14366; noise excitation by constant water flow with 0.5 l/s, 1.0 l/s, 2.0 l/s and 4.0 l/s (details in Annexes D and P).

Result:

Installation Sound Level $L_{AFeq,n}$ (L_{In}) [dB(A)] measuring room: UG rear (basement)				
Flow rate [l/s]	0,5	1,0	2,0	4,0
Test set-up: Wastewater system with insulating tube "ENERGOFLEX ACOUSTIC", manufacturer: Rols Isomarket.	18	21	24	26
Reference set-up: Rigid installation of the wastewater system. Pipe poured in the opening of the ceiling without pipe covering.	27	31	33	36
A-sound pressure level reduction $\Delta L_{A,F}$ in dB	9	10	9	10

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Test date: 21 November 2014

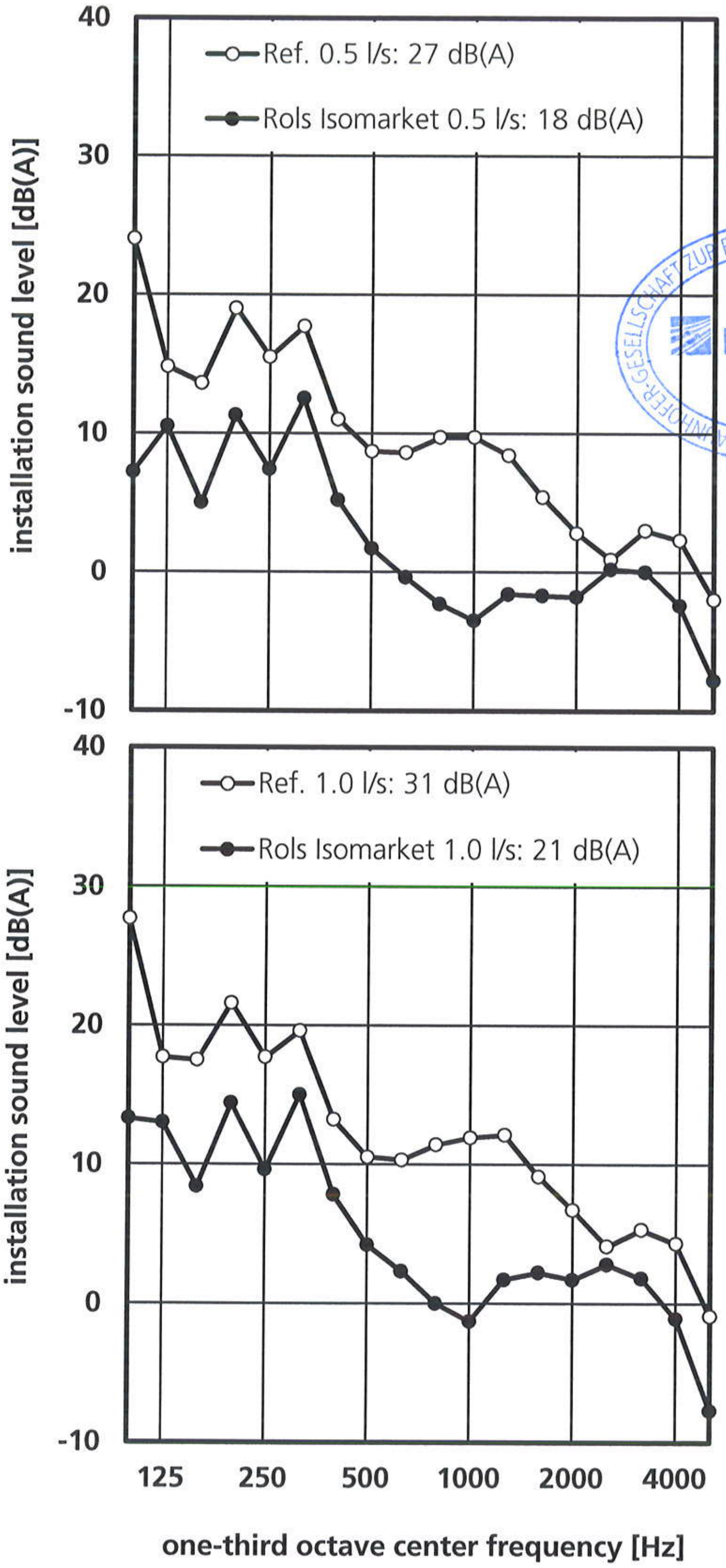
Notes:
- Measurements on the test specimen were carried out without applying pipe clamps or other fastening elements in order to exclusively determine the sound-insulating properties of the insulation material without additional structure-borne sound via pipe anchorage. Therefore the measured values are the lower limit for the installation sound level, which can be expected with the existence of similar types of structure sound bridges, when applying the analysed waste water structure-borne insulation system.

Detailed results

Client: ROLS ISOMARKET, Vyatskaya str. 27, 127015 Moscow

P-BA 316/2014e

figure 1



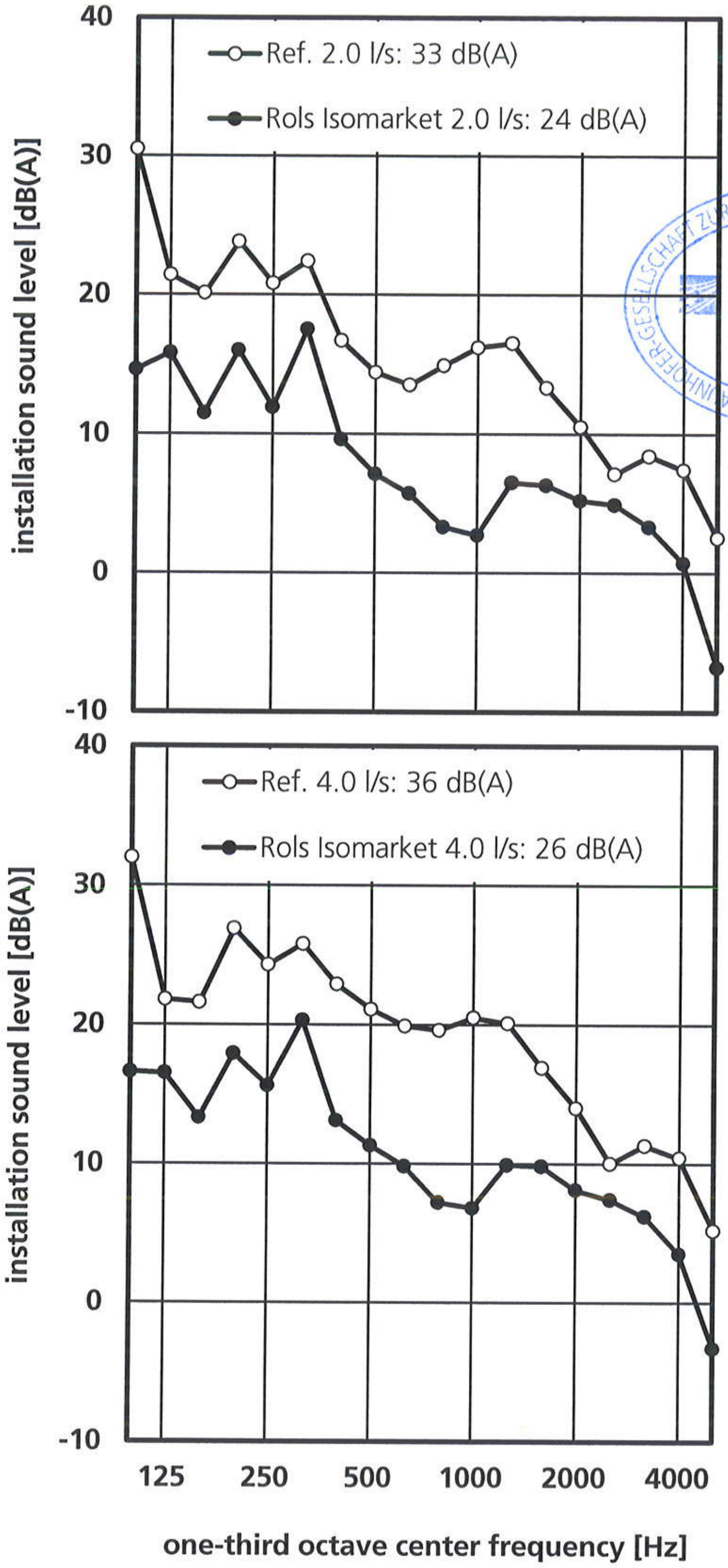
Frequency response of the installation sound level measured in the test room UG rear at flow rates 0.5 l/s (above) and 1.0 l/s (below). The installation sound levels $L_{AFeq,n}$ (L_{In}) in dB(A) according DIN 4109, for the reproduced frequency range from 100 to 5000 Hz, are represented in the legend.

Reference set-up: Rigid installation of the wastewater system

Test set-up: Wastewater system with insulating tube "ENERGOFLEX ACOUSTIC", Rols Isomarket.

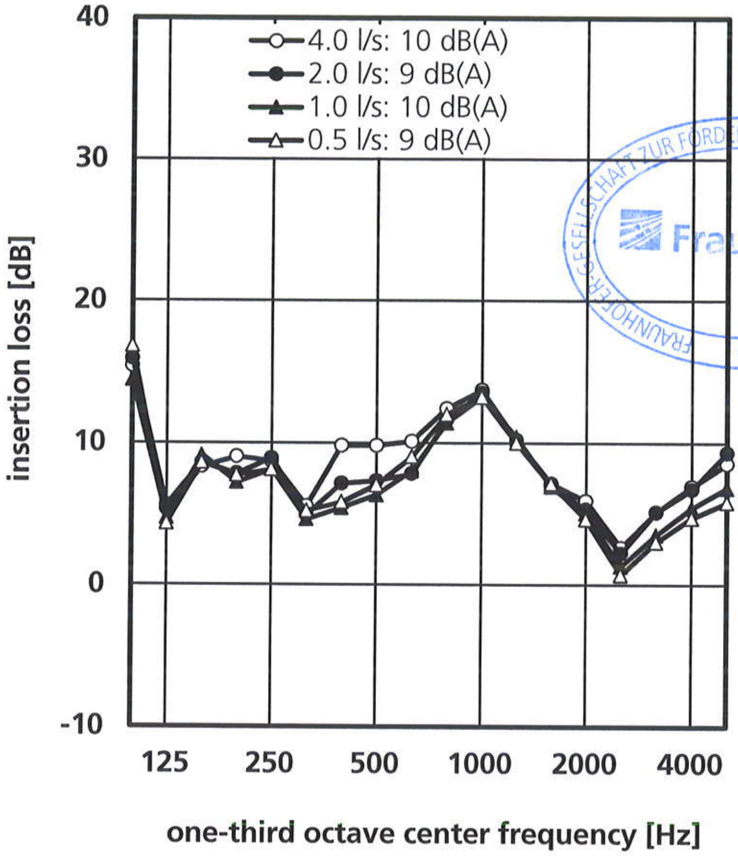
Details in results sheet 1.

Detailed results Client: ROLS ISOMARKET, Vyatskaya str. 27, 127015 Moscow	P-BA 316/2014e figure 2



Frequency response of the installation sound level measured in the test room UG rear at flow rates 2.0 l/s (above) and 4.0 l/s (below). The installation sound levels $L_{AFeq,n}$ (L_{In}) in dB(A) according DIN 4109, for the reproduced frequency range from 100 to 5000 Hz, are represented in the legend.
Reference set-up: Rigid installation of the wastewater system
Test set-up: Wastewater system with insulating tube "ENERGOFLEX ACOUSTIC", Rols Isomarket.
Details in results sheet 1.

Detailed results Client: ROLS ISOMARKET, Vyatskaya str. 27, 127015 Moscow	P-BA 316/2014e figure 3

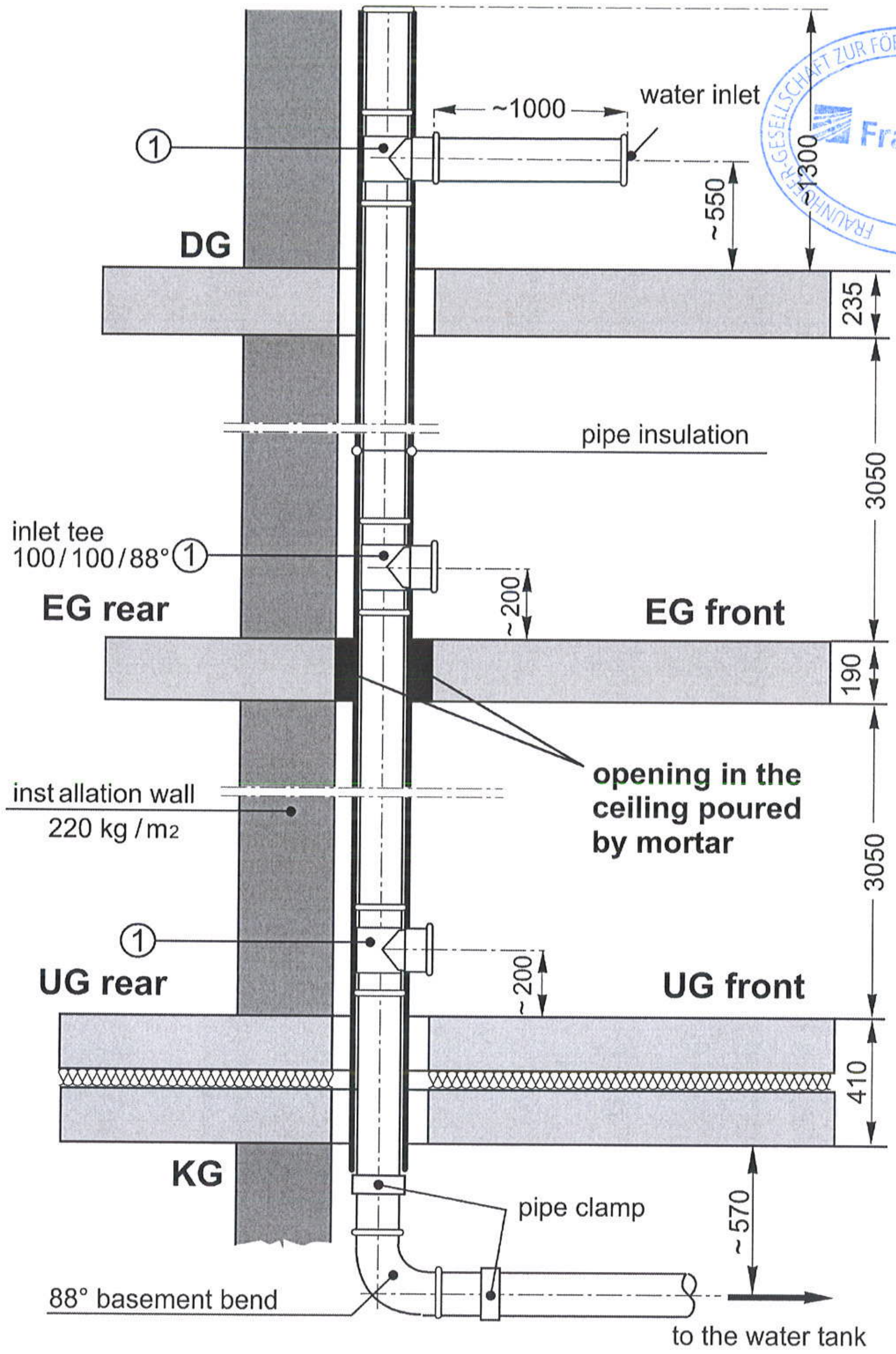


Frequency response of insertion loss D_e by noise excitation at various flow rates 4.0 l/s, 2.0 l/s, 1.0 l/s and 0.5 l/s, measured in the test room UG rear. The A-weighted reduction of sound level $\Delta L_{A,F}$ (referring to excitation by the various flow rates), for the reproduced frequency range from 100 to 5000 Hz, are represented in the legend.

Test specimen:

Reference set-up: Rigid installation of the wastewater system
Test set-up: Wastewater system with insulating tube "ENERGOFLEX ACOUSTIC", Rols Isomarket.

Details about the test set-up in results sheet 1.



Installation plan of the waste water system (plastic pipes, HT, without pipe clamps) with the Insulating tube for wastewater installation systems "ENERGOFLEX ACOUSTIC", manufacturer: Rols Isomarket (drawing not to scale, dimensions in mm).

Realization of measurement

The insertion loss D_e describes the reduction of the installation sound level of waste water pipes by means of structure-borne sound insulating tubes or elastic mounting elements (e.g. pipe clamps) compared to a rigid attachment of the pipe to the wall. The measurements are performed according to DIN EN 14366 and the German standards DIN EN ISO 10052, DIN 4109-11 and DIN 4109, in which in situ measurements of the noise behavior of water installations are described. The execution of the measurements take place in two steps:

1. Measurement of the installation sound level of a reference set-up with a rigid attachement of the pipe without pipe covering. Wastewater pipe respectively poured by mortar in the opening in the ceiling between ground floor and basement..
2. Measurement of the installation sound level of the same pipe supplied with the structure-borne sound insulating tube or the elastic mounting element under test.

Noise excitation and evaluation parameters

Any defined and metrological reproducible noise excitation requires steady state flow conditions inside the wastewater pipes. As the noise generation in waste water systems depends on the flow rate, noise measurements are usually performed at several flow rates Q which are typically encountered in practice:

(1) Q = 0.5 l/s, corresponding to Q = 30 l/min,
(2) Q = 1.0 l/s, corresponding to Q = 60 l/min,
(3) Q = 2.0 l/s, corresponding to Q = 120 l/min,
(4) Q = 4.0 l/s, corresponding to Q = 240 l/min.

Here, a flow rate of Q = 2.0 l/s roughly corresponds to the average flow rate required for flushing a toilet. According to Prandtl-Colebrook, the highest flow rate used results from the admissible hydraulic charge of the horizontal pipe sections, which is Q_{max} = 4 l/s for OD 110 pipes.

The measurements take place in the room behind the installation wall (UG rear). The water flow generates vibrations of the wastewater pipe. These vibrations are transmitted to ceiling and the installation wall through pipe clamps and/or other structure-borne sound bridges (e.g. fire protection sleeves), and then radiated by the wall (and to a lesser extent, also by the adjoining building parts) as airborne sound into the test room behind the installation wall. Differing from German standard DIN EN ISO 10052 the sound pressure level is recorded at six points spread in the receiving room. In this way an averaging in space and time is reached, causing an improvement of exactness and reproducibility of the measuring results to take account to the raised requirements for laboratory measurements. Thereby the rounded $L_{AF,10}$ is equivalent to the installation sound level L_{In} (or $L_{AFmax,n}$) according to DIN EN ISO 10052, DIN 4109-11 and DIN 4109.

Measurement set-up

In the water-installation test-facility run by the Fraunhofer Institute of Building Physics, a down pipe is installed leading from the top floor (DG) down to the sub-basement (KG) (for further details, please see Annex P). This down pipe is connected to a (OD 110) water inlet pipe on the top-floor level. The water is introduced through an S-shaped bend according to the standard DIN EN 14366. In the sub-basement, the down pipe is connected to a bend (2 x 45°, or 1 x 88°, usually) and merges into a horizontal discharge section, which in turn is joined to a water receptacle. The waste-water pipe on the ground floor (EG) and in the basement (UG) is fitted with conventional branches from main lines (usually, OD 110). Pipes and fittings are mounted according to the instructions given by the manufacturer.

Reference set-up

To determin the insertion loss of the samples a waste water pipe is poured by mortar in the opening in the ceiling (190 cm concrete) between ground floor and basement. The test facility is shown schematically in annex P. The reference set-up resembles in all details (except for the pipe insulating material) the measurement set-up with the object under test.

Measurement set-up with test object

The measurement set-up with test object is almost identical with the reference set-up. The only difference is, that the pipe is covered by the pipe insulation under test befor pouring the pipe in the opening of the ceiling. In case of structure-borne sound insulating tubes the pipe is completely encased in the insulating material.

Evaluation of measuring data and determination of acoustic parameters

The measured sound pressure level is given as a time and space averaged one-third octave spectrum in the frequency range between 100 Hz and 5 kHz. First, the value is corrected for background noise. Subsequently, the measurement signal is normalized to an equivalent sound absorption area A_0 = 10 m² and A-weighted:

(1) $$L_{n,AF,10} = 10 \cdot \lg\left(10^{\frac{L_{n,F}}{10}} - 10^{\frac{L_{n,S}}{10}}\right) + 10 \cdot \lg \frac{A_n}{A_0} + k(A)_n \quad [\text{dB(A)}]$$

$L_{n,F}$	space and time averaged sound pressure level in one-third octave band n (time constant: Fast)	[dB]
$L_{n,S}$	background noise level in one-third octave band n	[dB]
$A_n = \frac{0.16 \cdot V}{T_n}$	sound absorption area of test room for one-third octave band n	[m²]
V	volume of test room	[m³]
T_n	reverberation time of test room in one-third octave band n	[s]
$k(A)_n$	A-weighting for one-third octave band n	[dB]

If the difference between the two levels (i.e. the measured one-third octave level and the background noise level) is less than 3 dB, the correction for background noise will not be performed. Instead, the measured background noise level will be used (as an estimated maximum level). The total sound pressure level is obtained by energetically adding the one-third octave values.

(2) $$L_{AF,10} = 10 \cdot \lg\left(\sum_{n=1}^{18} 10^{\frac{L_{n,AF,10}}{10}}\right), \quad [\text{dB(A)}]$$

where n indicates the number of one-third octave bands from 100 Hz through 5 kHz. The calculated level $L_{AF,10}$ corresponds to the sound pressure level resultant in a sparsely furnished reception room under otherwise equal conditions.

The acoustic influence of the structure-borne sound insulating tube or the elastic mounting element under test is described by the frequency-dependent insertion loss D_e. The one-third octave values of the insertion loss $D_{n,e}$ are the difference between the one-third octave levels $L_{n,AF,10-0}$, measured with rigid attachement of the pipe, and the levels $L_{n,AF,10-1}$, measured with the insulating tube or the elastic mounting element under test

(3) $$D_{n,e} = L_{n,AF,10-0} - L_{n,AF,10-1}$$ [dB]

Additionally the reduction of the A-weighted sound level ΔL_{AF} by the test object is determined. For this purpose the A-weighted total sound pressure levels are subtracted from each other instead of the one-third octave levels.

(4) $$\Delta L_{AF} = L_{AF,10-0} - L_{AF,10-1}$$ [dB]

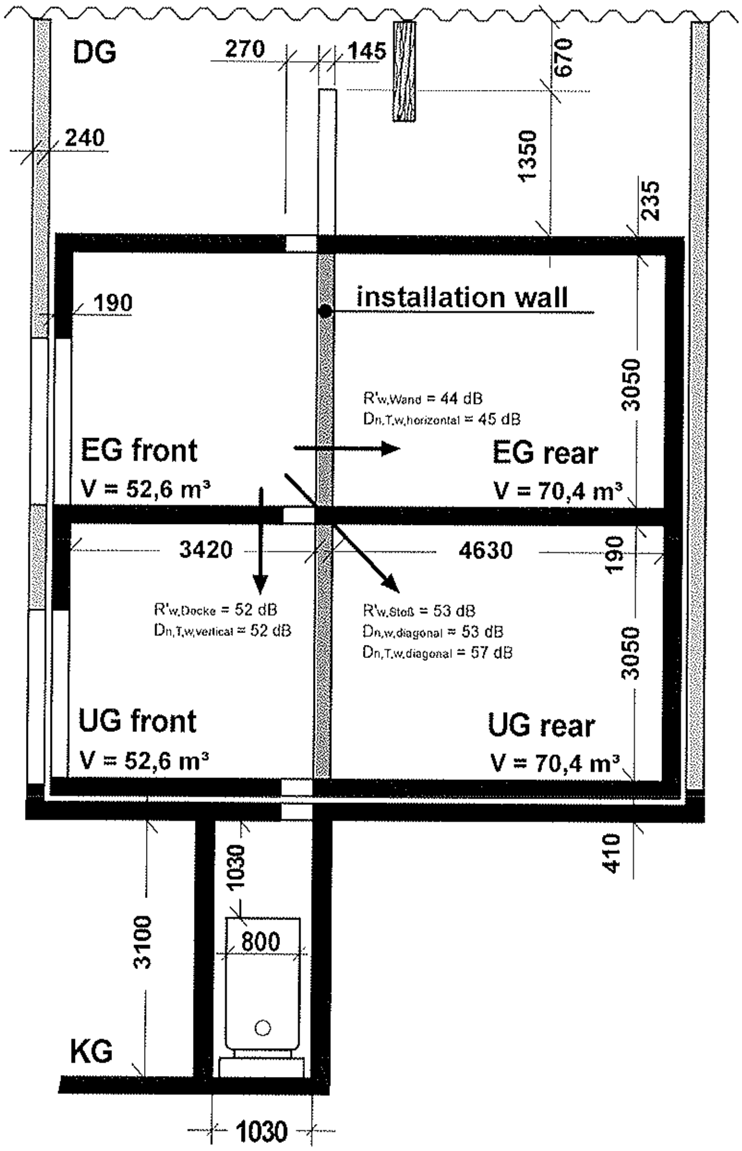
The reduction of the A-weighted sound level represents a measure for the decrease of noise felt by human ear using structure-borne sound insulating tubes or elastic mounting elements. It refers exclusively to the noise spectrum while excitating the pipe system by a stationary water flow (as used at the measurements) and can't be transferred directly to other types of noise sources.

Scope of the measurements

Transferability of the results to other building situations

Concerning the practical application of the measuring results it has to be noted that the reduction of the A-weighted sound level achieved in situ can deviate from the value indicated in the test report, if waste water systems are used, whose shape or nominal diameter differs substantially from the system under test. The same applies to waste water systems with different materials (cast iron, steel, or plastic). Different variations of installation, as for example the mounting under plaster, the mounting with other elastic mounting elements, etc., likewise influence the insertion loss. Moreover it has to be considered, that the attainable noise reduction in practice can be decreased by structure-borne sound bridges between the tap or the pipe and the building. In the values given here these side paths are not considered.

Test facility



Sectional drawing of the installation test facility in the Fraunhofer-Institute of Building Physics (dimensions given in mm). The test facility comprises two couples of rooms in the ground floor (EG) and in the basement (UG) that are located above each other. Due to this construction, including the top floor (DG) and the sub-basement (KG), it is possible to perform tests on installation systems which extend across several floors, e.g. waste-water installation systems. The installation walls in the ground floor and in the basement can be substituted according to actual requirements. In the standard case, single-leaf solid walls with a mass per unit area of 220 kg/m² (according to German standard DIN 4109) are used. Since the sound insulation of these walls do not meet the requirements to be fulfilled by a wall separating different occupancies within the same building ($R'_w \geq 53$ dB), the next adjacent rooms to be protected from noise are located diagonally above or below the installation room (in case of a usual design of the ground plan). Due to its double-leaf construction with an additional structure-borne sound insulation, the installation test facility is particularly suited for measuring low sound pressure levels. The measuring rooms are designed in such a way that the reverberation times are between 1 s and 2 s within the examined frequency range. The flanking walls, with an average mass per unit area of approximately 440 kg/m², are made of concrete.

Measurement equipment

Following measurement equipment was used for the measurments in the installation test facility P12 of the Fraunhofer-Institute for Building Physics:

Device	Type	Manufacturer
Analyser	Soundbook_MK2_8L	Sinus Messtechnik
½"-microphone-Set	46 AF (Kapsel: Typ 40 AF-Free Field; Vorverstärker: Typ 26 TK)	G.R.A.S
1"-microphone	4179	Bruel & Kjær
1"-preamplifier	2660	Bruel & Kjær
Microphone-calibrator	4231	Bruel & Kjær
Accelerometer	4371 und 4370	
Conditioning amplifier	Nexus 2692-A-0I4	Bruel & Kjær
Accelerometer-calibrator	VC11	MMF
Amplifier	LBB 1935/20	Bosch Plena
Loudspeaker	MLS 82	Lanny
Reference sound source	382	Rox
Standard tapping machine	211	Norsonic

All measurement devices are tested frequently by internal and external testing laboratories and, if possible and necessary, are calibrated and gauged.