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Test report P-BA 214/2010e

Determination of the Acoustic Performance of a Wastewater Installation System in the Laboratory

Client: Düker GmbH & Co. KGaA
Würzburger Straße 10
97753 Karlstadt/Main
GERMANY

Test specimen: Wastewater installation system consisting of "DÜKER SML" cast iron pipes and fittings (manufacturer: Düker) mounted with different pipe clamps

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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.

Stuttgart, January 25, 2011

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

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# Determination of the installation sound level L_{In} in the laboratory	P-BA 214/2010e **Table 1**

Client: Düker GmbH & Co. KGaA, Würzburger Straße 10, 97753 Karlstadt/Main, GERMANY

Test specimen: Wastewater installation system consisting of "DÜKER SML, DN 100" cast iron pipes and fittings (manufacturer: Düker) mounted with steel pipe clamps without elastomer inlay and with "acoustic decoupler" by Düker (test specimen S 10320-01) as well as with standard steel pipe clamps with elastomer inlay (test specimen S 10320-02).

Test set-up: Installation of the pipe system according to figure 6 and Annex A. First test set up was the pipe system "DÜKER SML, DN 100" with steel pipe clamps without elastomer inlay and with "acoustic decoupler". After the measurements the pipe clamps were replaced by standard steel pipe clamps with elastomer inlay and the measurements were repeated.

- Pipe system "DÜKER SML, DN 100": cast iron pipes and fittings without sockets, tested and produced according to EN 877, with GEG test mark. Diameter DN 100, OD 110, weight ca. 8.4 kg/m. Connection of the pipes and fittings by "Dükorapid coupling".
- Pipe clamps: steel pipe clamps without elastomer inlay and with "acoustic decoupler" (item no. 239681) by Düker as well as with standard steel pipe clamps with elastomer inlay. In every storey (UG and EG) two pipe clamps were installed. All clamps as fix clamps completely closed and fixed to the installation wall with wall plugs and thread rods.
- Down pipe support (item no. 661564) with top ring by Düker mounted in the sub-basement (KG).

The system consisted of straight pipes (DN 100), three inlet branches, two 45°-basement bends with intermediate calming section and a horizontal drain section. The inlet branches in the basement and in the ground floor were closed by lids supplied by the manufacturer. Connection of the pipes by "Dükorapid coupling" by Düker. The pipe system was mounted by the client.

Test facility: Installation test facility P12, mass per unit area of the installation wall: 220 kg/m², installation rooms: sub-basement (KG), basement (UG) front, ground floor (EG) front and top floor (DG), measuring rooms: UG front, UG rear (details in Annex P and EN 14366: 2005-02).

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

Results:

Pipe system "Düker SML" with steel pipe clamps without elastomer inlay and with "acoustic decoupler"				
Flow rate [l/s]	0,5	1,0	2,0	4,0
Installation sound level L_{In} [dB(A)] measured in UG front	37	42	44	48
Installation sound level L_{In} [dB(A)] measured UG rear	<10	<10	<10	13
Airborne sound pressure level $L_{a,A}$ [dB(A)] [1]	37	42	44	48
Structure-born sound characteristic level $L_{sc,A}$ [dB(A)] [1]	<10	<10	<10	11
Pipe system "Düker SML" with standard steel pipe clamps with elastomer inlay				
Flow rate [l/s]	0,5	1,0	2,0	4,0
Installation sound level L_{In} [dB(A)] measured in UG front	38	42	45	48
Installation sound level L_{In} [dB(A)] measured in UG rear	11	16	20	26
Airborne sound pressure level $L_{a,A}$ [dB(A)] [1]	38	42	45	48
Structure-born sound characteristic level $L_{sc,A}$ [dB(A)] [1]	<10	14	19	24

[1]) Evaluation according to EN 14366.

Date of tests: October 13 and 14, 2010

Comments:

- Sound levels below 10 dB(A) are not mentioned in the test report, since they are subject to an increased measurement uncertainty and moreover are not noticeable in a normal living environment.
- The requirements of DIN 4109 only apply for the Installation sound level L_{In} measured in test room UG rear. The investigated test object in combination with the present building situation (test facility) meets the requirements for the Installation sound level L_{In} according to DIN 4109 (DIN 4109/A1:2001).

Fraunhofer IBP

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.
Stuttgart, January 25, 2011
Head of Laboratory:

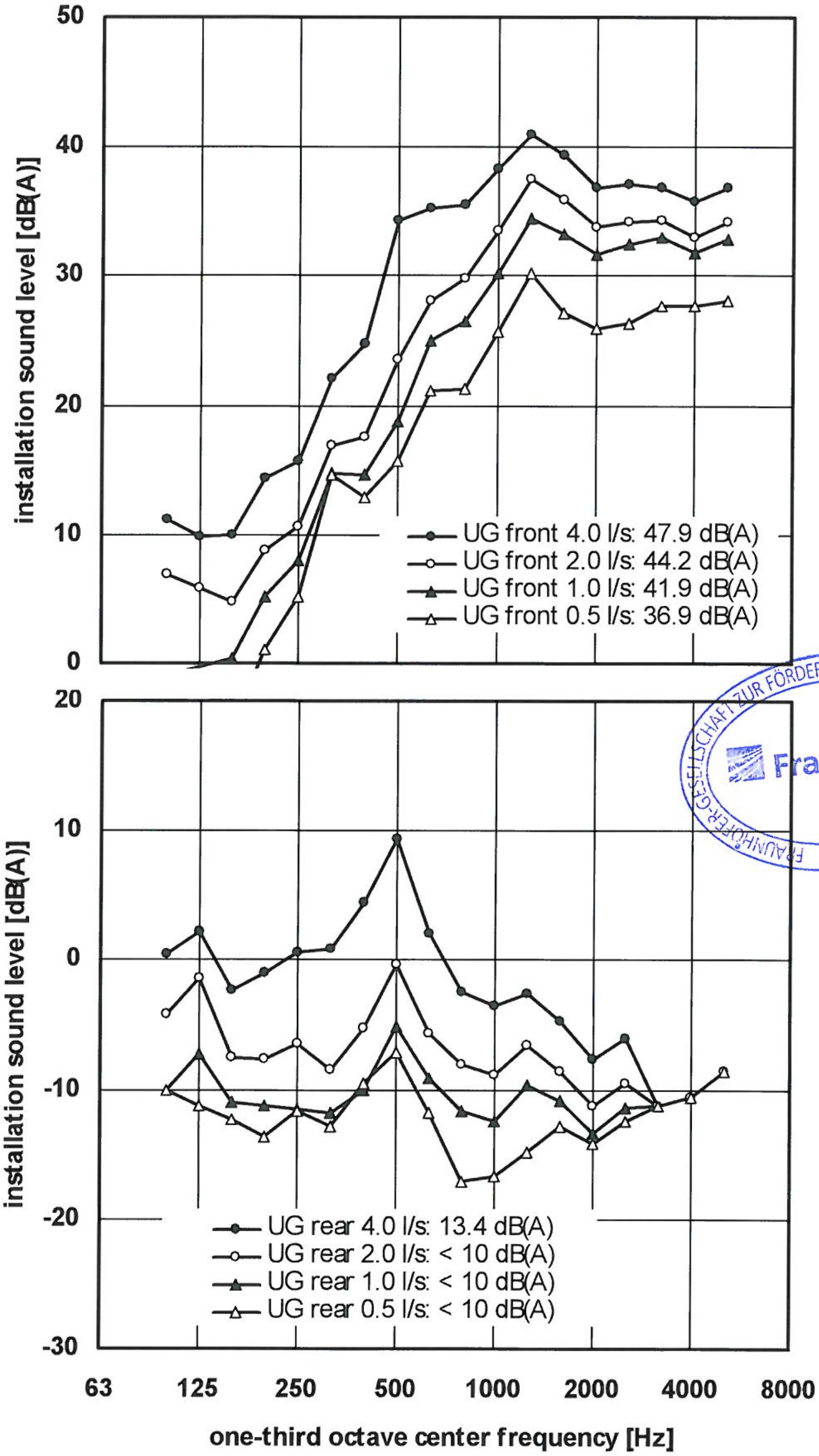


Figure 1 Wastewater pipe system "DÜKER SML" mounted according to figure 6, using steel pipe clamps without elastomer inlay and with "acoustic decoupler". The installation sound level L_{In} was measured at various flow rates in the test rooms UG front (above) and UG rear (below).

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.

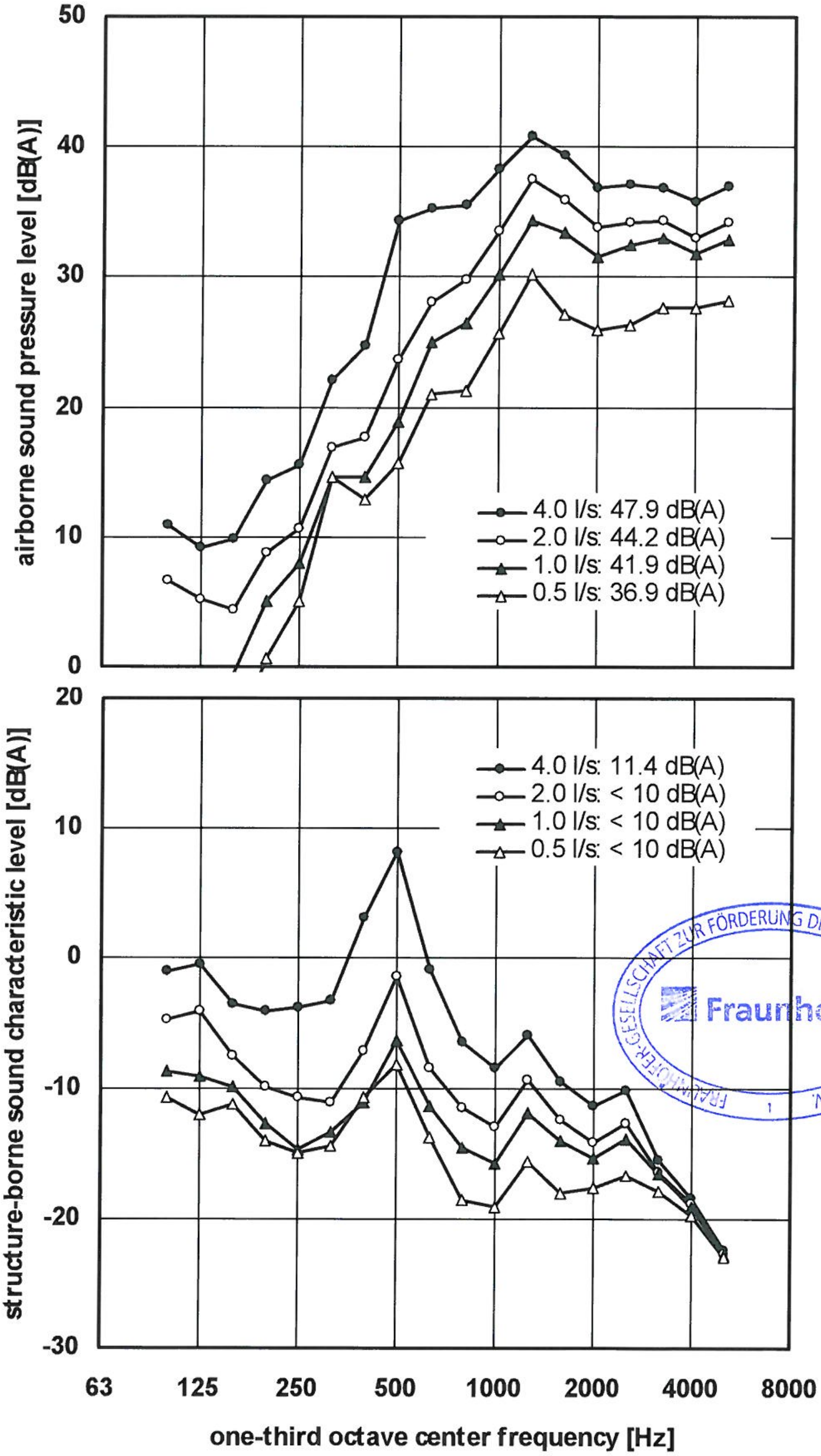


Figure 2 Wastewater pipe system "DÜKER SML" mounted according to figure 6, using steel pipe clamps without elastomer inlay and with "acoustic decoupler". Airborne sound pressure level (above) and structure-born sound characteristic level (below) measured at various flow rates according to DIN EN 14366.

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.

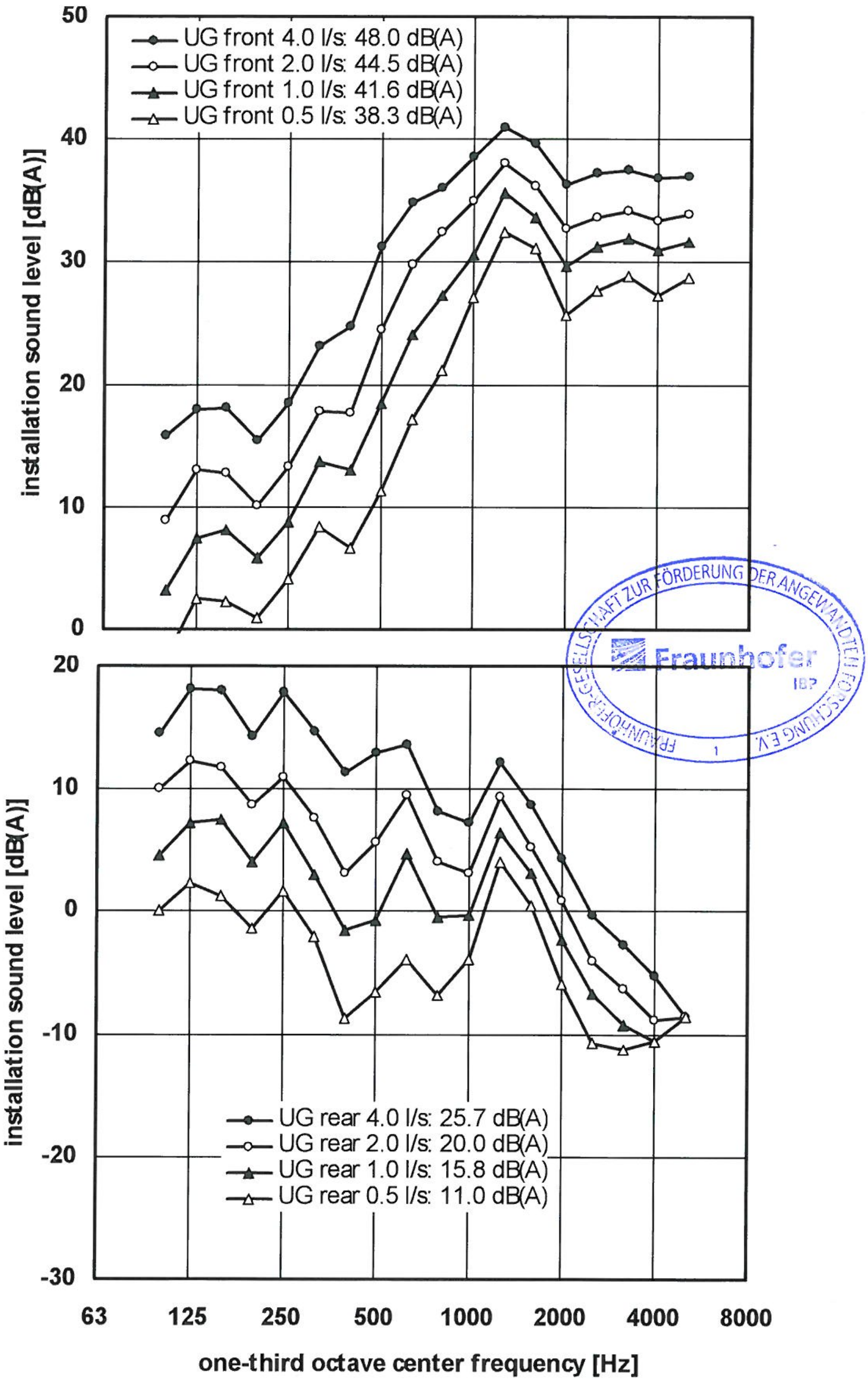


Figure 3 Wastewater pipe system "DÜKER SML" mounted according to figure 6, using standard steel pipe clamps with elastomer inlay. The installation sound level L_{In} was measured at various flow rates in the test rooms UG front (above) and UG rear (below).

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.

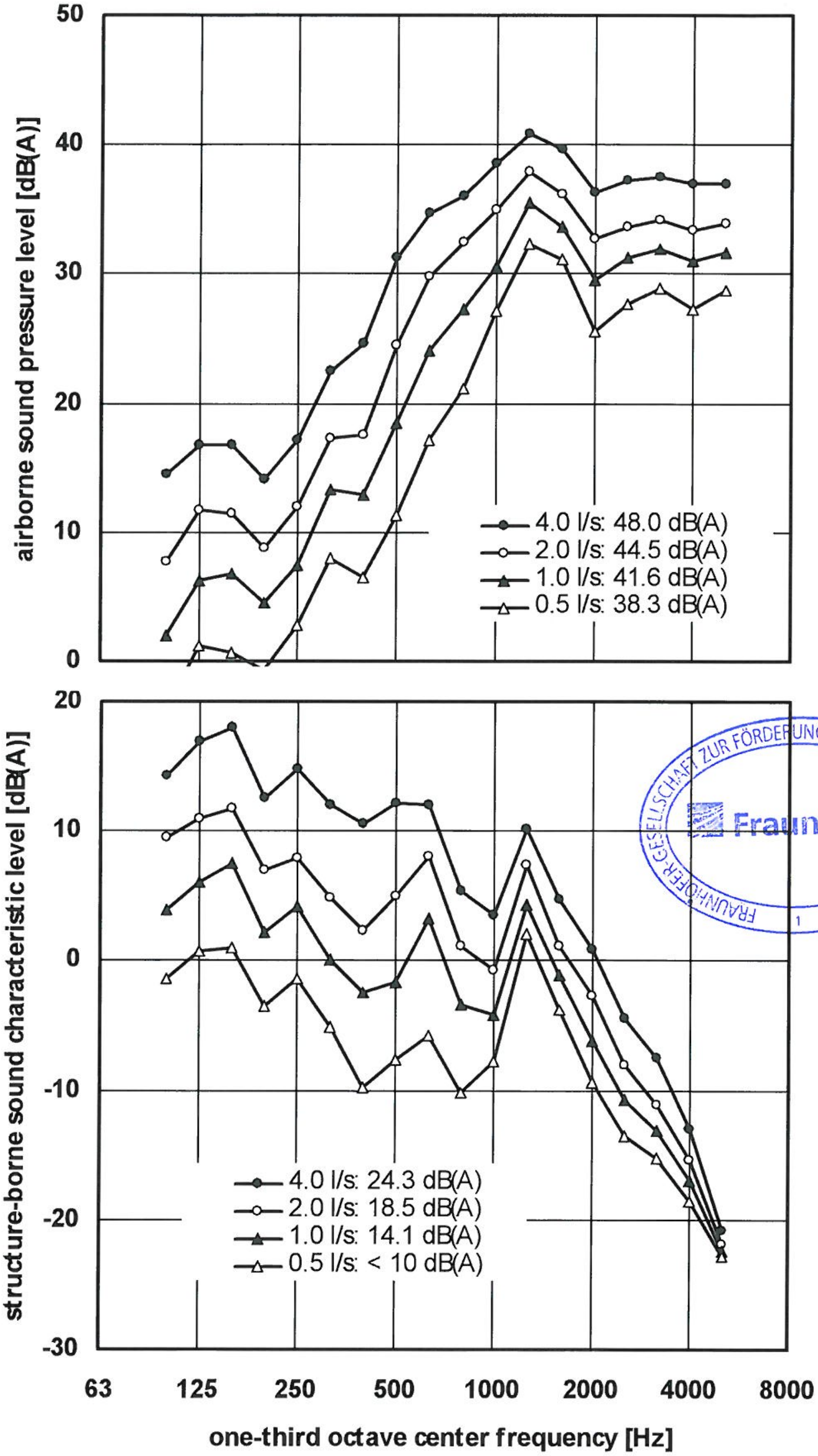


Figure 4 Wastewater pipe system "DÜKER SML" mounted according to figure 6, using standard steel pipe clamps with elastomer inlay. Airborne sound pressure level (above) and structure-born sound characteristic level (below) measured at various flow rates according to DIN EN 14366.

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.

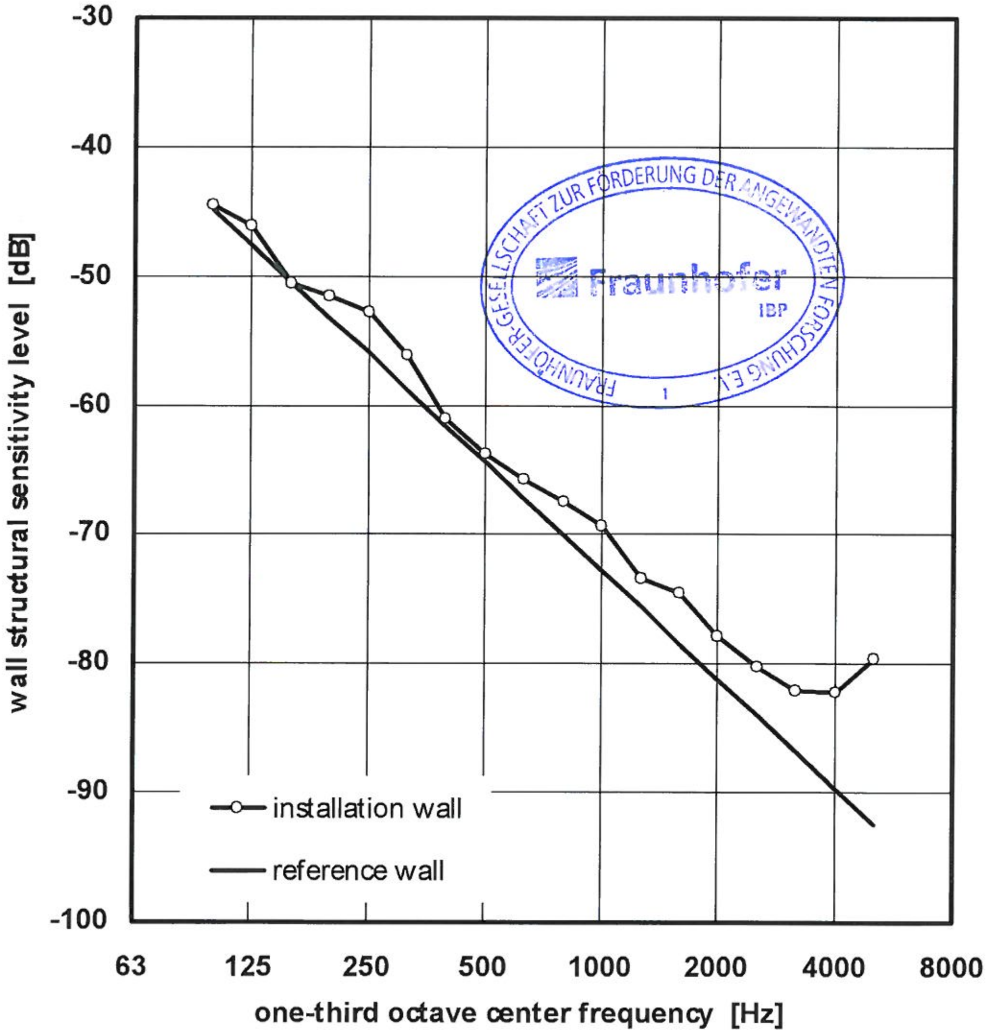


Figure 5 Wall structural sensitivity level L_{SS} of the installation wall between the test rooms UG front and UG rear in the installation test facility in the Fraunhofer-Institute of Building Physics. The installation wall consists of lime stones (thickness 115 mm, ceiled on both sides) with a mass per unit area of 220 kg/m². The indicated structural sensitivity level L_{SS} refers to the mounting position of the waste water system according to figure 6. For comparison the wall structural sensitivity level L_{SSR} of the reference wall is also indicated (evaluation according to DIN EN 14366).

The tests were performed in a a laboratory accredited by the German Accreditation System for Testing (DAP, file no. PL-3743.26) according to standard EN ISO/IEC 17025.

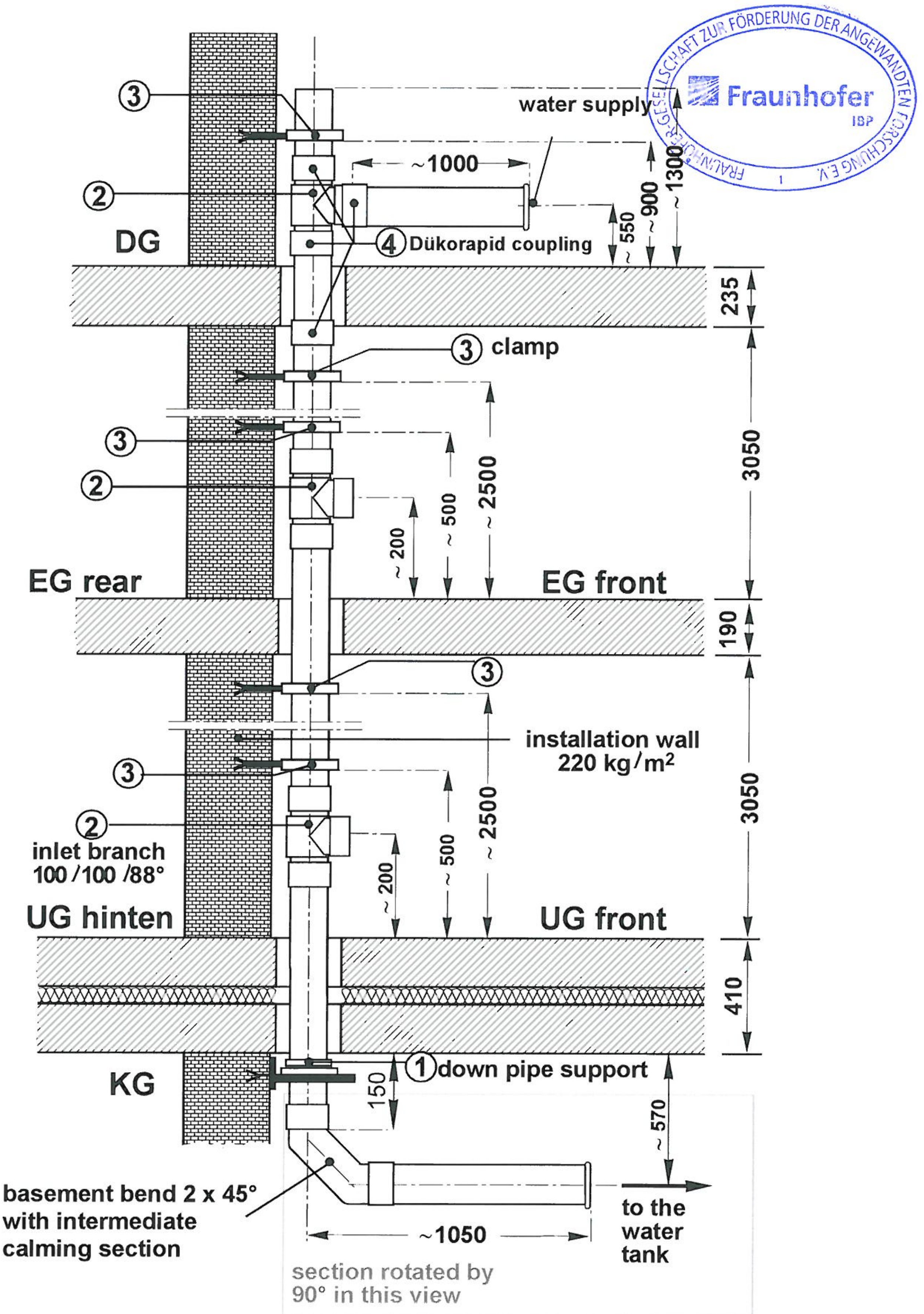


Figure 6 Installation plan of the pipe system "DÜKER SML" mounted with steel pipe clamps without elastomer inlay and with "acoustic decoupler" as well as (second measurement) with standard steel pipe clamps with elastomer inlay. Drawing not to scale, dimensions in mm.

Measurement set-up, noise excitation and evaluation parameters

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 EN 14366. In the sub-basement, the down pipe is connected to a bend (2 x 45 degree, 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. The air gaps between the tube and floor in the entrance and exit openings are stuffed with porous absorber in order to prevent any structure-borne sound bridges influencing the building. The waste-water piping is fastened to the installation wall (mass per unit surface m'' = 220 kg/m^2) by means of pipe clamps supplied by the Client, which are adapted to the external diameter of the pipes. The locations of the fixation points and further dimensions are specified in the installation plan that is included in the test report.

Noise excitation and evaluation parameters

Any defined and metrological reproducible noise excitation requires steady state flow conditions inside the waste-water pipes. As the noise generation in waste water systems depends on the flow rate, noise measurements are 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 installation room (UG front) and in the room behind the installation wall (UG rear). The water flow generates vibrations of the wastewater pipe. These vibrations are transmitted to 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. In the test room UG front additionally the airborne sound which is radiated from the waste water system is measured. According to EN ISO 140-3 the sound pressure level is picked up at six points in the room, to be space and time-averaged and corrected for the background noise. With this value the airborne sound pressure level $L_{a,A}$ and the structure-borne sound characteristic level $L_{sc,A}$ is calculated according to EN 14366. The installation sound level is determined following Annex F. Thereby the rounded $L_{AF,10}$ is equivalent to the installation sound level L_{In} (or $L_{AFmax,n}$) according to DIN 52219, DIN EN ISO 10052, DIN 4109-11 and DIN 4109.

Evaluation of Measurements

Stationary noise

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

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

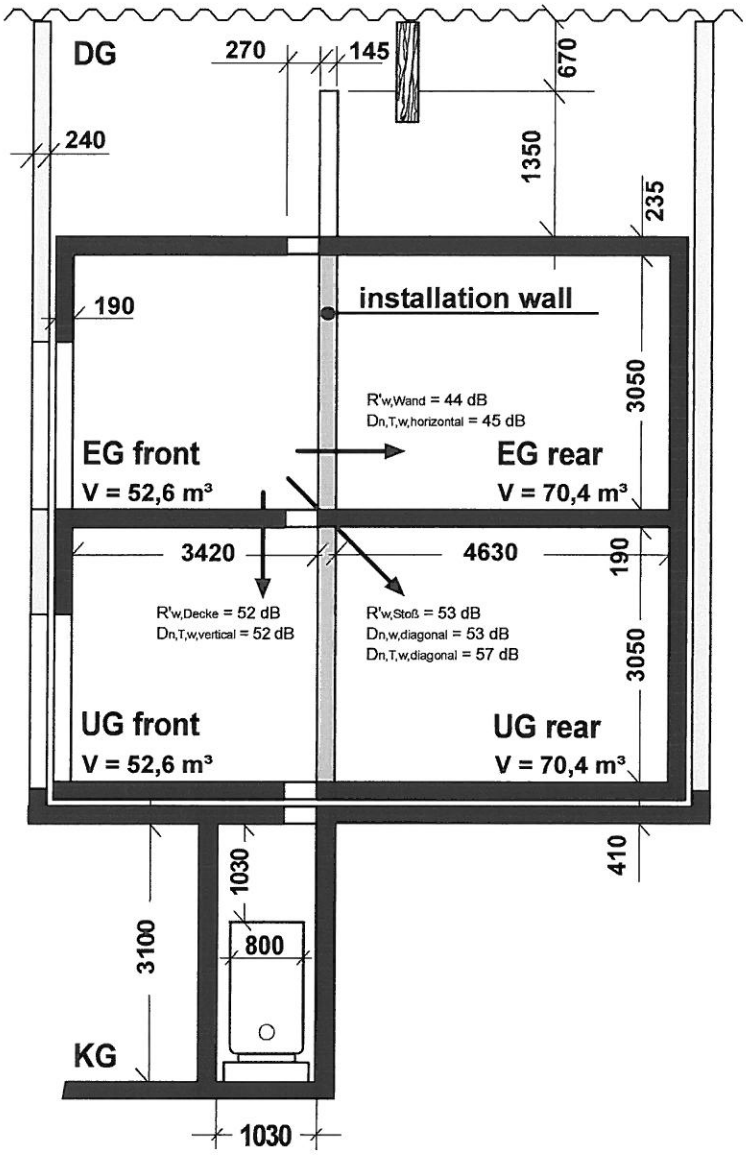
If the difference between the measured one-third octave level and the background noise level is less than 3 dB, the correction for background noise will not be performed. Instead, the measured background noise level will be used as test result (as largest possible value). The total sound pressure level is obtained by energetically adding the one-third octave values.

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

where n indicates the number of one-third octave bands from 100 Hz to 5 kHz. The calculated level $L_{AF,10}$ corresponds to the sound pressure level that would arise in a sparsely furnished reception room under otherwise equal conditions. The value ($L_{AF,10}$) represents the installation sound level L_{In} (or $L_{AFmax,n}$) in the test facility.

Time-dependent noise

In this case, the measurement signal consists of a series of one-third octave spectra (frequency range from 100 Hz through 5 kHz) which are consecutively measured at the same place with a time interval of 0.128 s. The evaluation is performed in the same way as in the case of stationary noise, with the exception that background noise correction is not performed. After evaluation the maximum value ($L_{AF,10,max}$) is determined from the measured time response.



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.