



## Test report P-BA 288/2007e

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

**Client:** NUEVA TERRAIN S. L.  
Paduleta, 2  
01015 VITORIA  
SPAIN

**Test specimen:** Wastewater installation system consisting of "TERRAIN SDP  
STANDARD PVC, 110x3.2" plastic pipes (manufacturer:  
NUEVA TERRAIN S. L.) mounted with pipe clamps "sound  
proof support bracket" (manufacturer: REHAU).

**Contents:** Table 1: Summary of test results  
Figures 1 to 3: Detailed results  
Figure 4: Installation plan  
Annex A: Measurement set-up, noise excitation,  
acoustic parameters  
Annex F: Evaluation of measurements  
Annex P: Description of test facility

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.

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Physics (IBP).

Stuttgart, December 19, 2007

Responsible Test Engineer: Head of Laboratory:

Dipl.-Ing.(FH) J. Mohr

Dr. rer. nat. L. Weber

# Determination of the installation sound level $L_{in}$ in the laboratory

P-BA 288/2007e

Table 1

- Client:** NUEVA TERRAIN S. L., Paduleta, 2, 01015 VITORIA, SPAIN
- Test specimen:** Wastewater installation system (test specimen S 9961-01) consisting of "TERRAIN SDP STANDARD PVC, 110x3.2" plastic pipes and fittings (manufacturer: NUEVA TERRAIN S. L.) mounted with pipe clamps "sound proof support bracket" (manufacturer: REHAU).
- Test set-up:**
- The pipe system was mounted according to Figure 4 (see also Annex A).
  - The system consisted of wastewater pipes (nominal size OD 110), three inlet tees (45°), two 45°-basement bends and a horizontal drain section. The inlet tees in the basement and in the ground floor were closed by lids supplied by the manufacturer. The pipe system was mounted by a technical firm.
  - Pipe system "TERRAIN SDP STANDARD PVC, 110x3.2": size OD 110, one-layer pipe with attached sleeve, material: PVC, wall thickness 3.2 mm, weight 1.64 kg/m, density 1.45 g/cm<sup>3</sup>. One-layer fittings "TERRAIN SDP STANDARD PVC, 110x3.2", size OD 110, material: PVC, wall thickness 3.2 mm, density 1.45 g/cm<sup>3</sup>. Connection of the pipes by plug-on socket connection. (Values are manufacturer's information.)
  - Pipe clamps "sound proof support bracket" consisting of supporting and fixing clips and loose clips, all with rubber inlay. The pipe clamps were fixed to the installation wall with dowels and thread rods.
- Test facility:** Installation test facility P12, mass per unit area of the installation wall: 220 kg/m<sup>2</sup>, 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 German standard DIN 52 219: 1993-07 and EN 14366; noise excitation by permanent 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:

Waste water system " TERRAIN SDP STANDARD PVC, 110x3.2" with pipe clamps "sound proof support bracket"				
Flow rate [l/s]	0,5	1,0	2,0	4,0
Installation sound level $L_{in}$ [dB(A)] measured in the basement test-room UG front	44	49	51	54
Installation sound level $L_{in}$ [dB(A)] measured in the basement test-room UG rear	4	8	13	18
Airborne sound pressure level $L_{s,A}$ [dB(A)] <sup>1)</sup>	44	49	51	54
Structure-borne sound characteristic level $L_{s,c,A}$ [dB(A)] <sup>1)</sup>	1	5	10	14

<sup>1)</sup> Evaluation according to EN 14366.

**Date of tests:** November 5, 2007

**Comments:** - The requirements of DIN 4109 only apply for the installation sound level  $L_{in}$  measured in the test room UG rear.



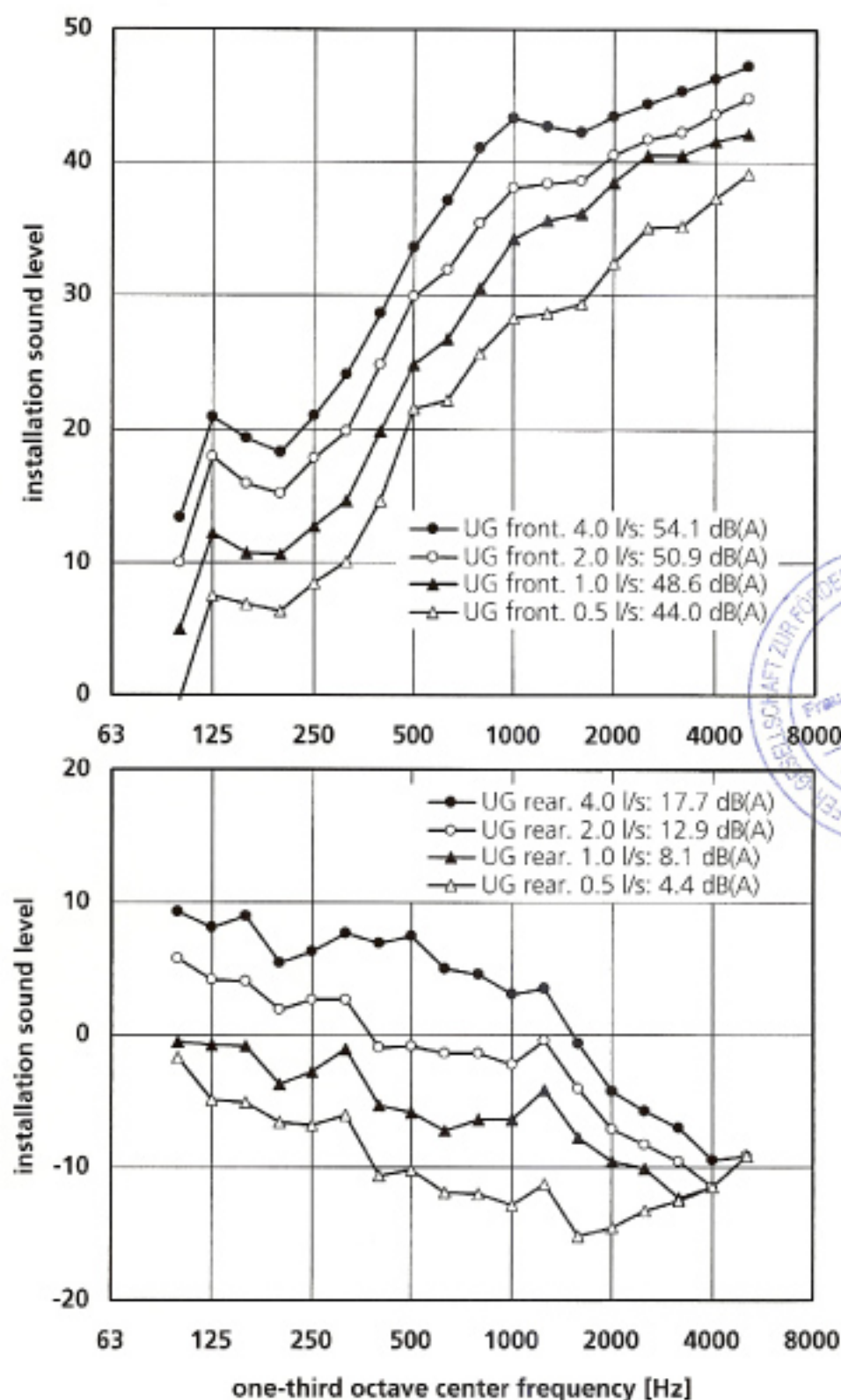
**Fraunhofer**  
Institut  
Bauphysik

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, December 19, 2007

Head of Laboratory:

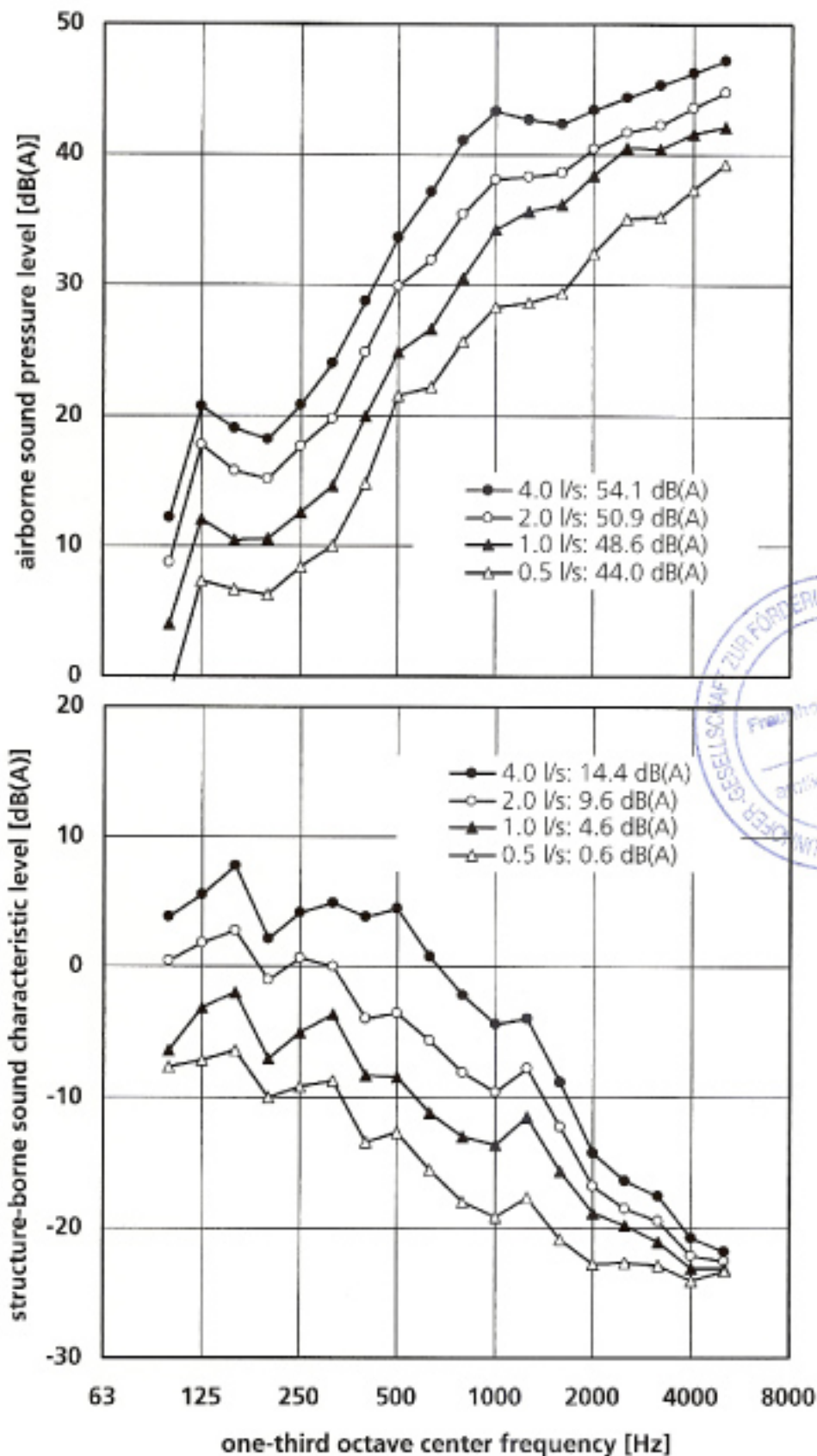
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**Figure 1** Wastewater pipe system "TERRAIN SDP STANDARD PVC, 110x3.2" mounted in sub-basement (KG), basement (UG front), ground floor (EG front) and top floor (DG) using pipe clamps "sound proof support bracket" (manufacturer: REHAU). The installation sound level  $L_{in}$  was measured at various flow rates in the test rooms UG front (above) and UG rear (below).

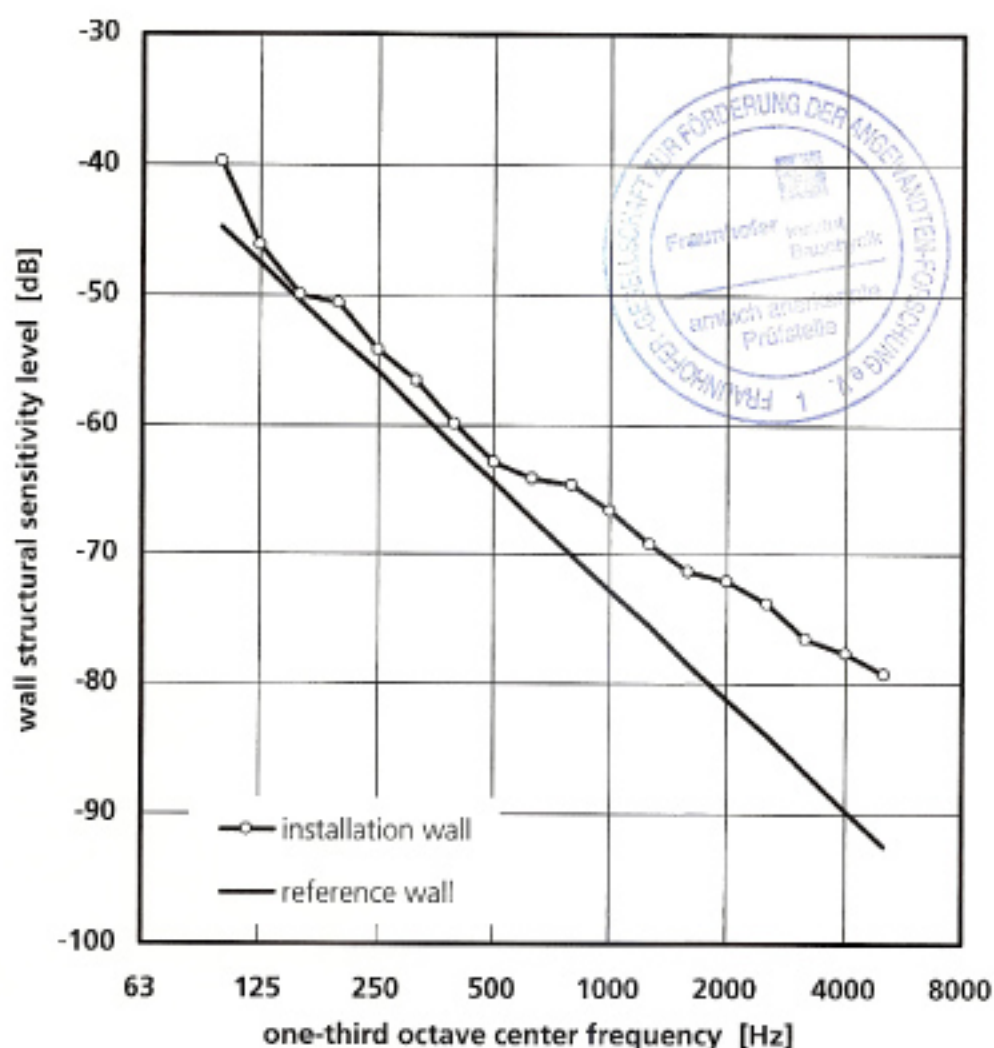
The tests were performed in a laboratory accredited by the German Accreditation System for Testing (DAP, file no. PL-3743.26) according to standard EN ISO/IEC 17025.





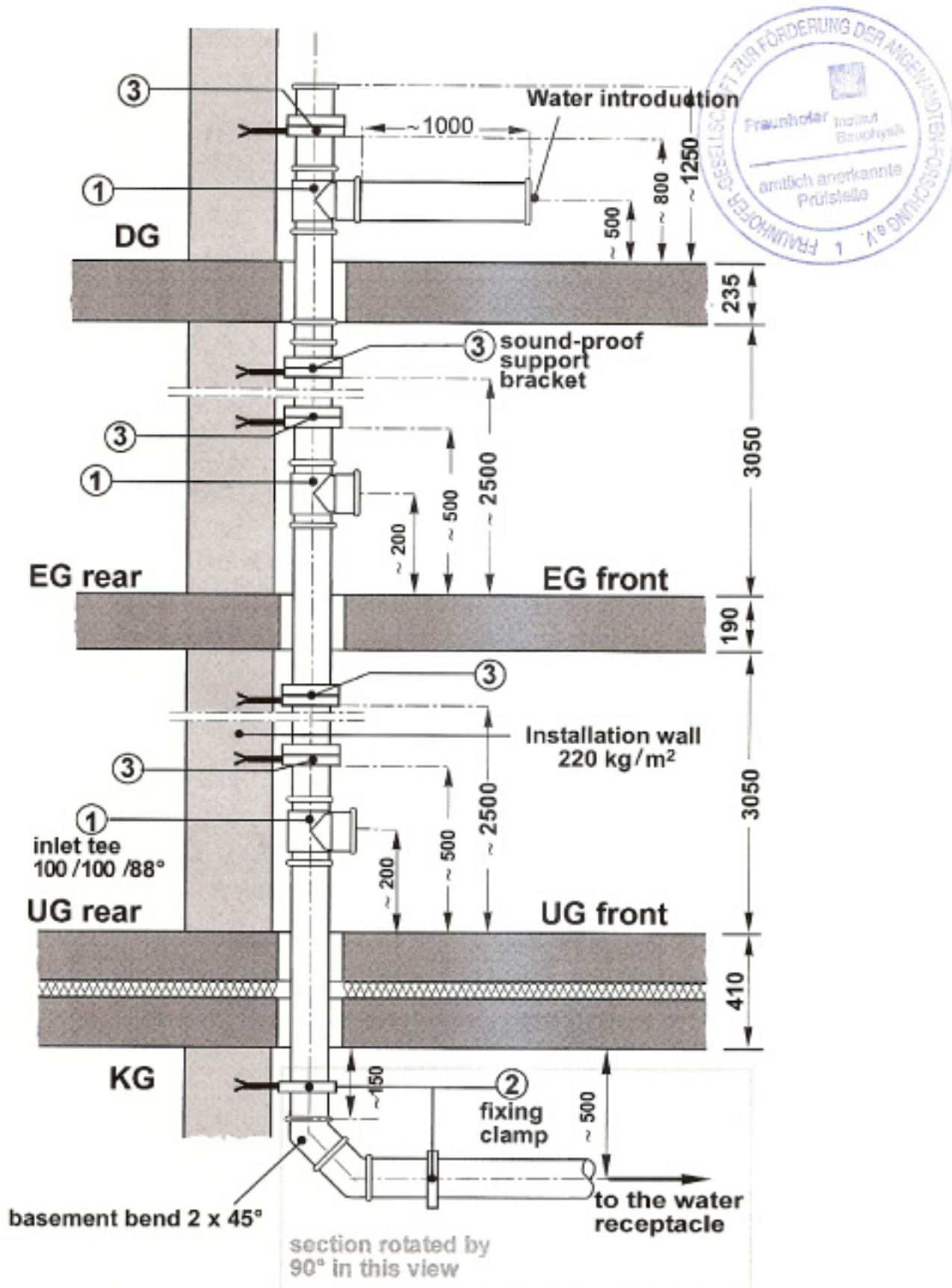
**Figure 2** Wastewater pipe system "TERRAIN SDP STANDARD PVC, 110x3.2" mounted in sub-basement (KG), basement (UG front), ground floor (EG front) and top floor (DG) using pipe clamps "sound proof support bracket" (manufacturer: REHAU). Airborne sound pressure level (above) and structure-borne sound characteristic level (below) measured at various flow rates according to 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** 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  $220 \text{ kg/m}^2$ . The indicated structural sensitivity level  $L_{SS}$  refers to the mounting position of the waste water system according to figure 4. For comparison the wall structural sensitivity level  $L_{SSR}$  of the reference wall is also indicated (evaluation according to EN 14366).

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**Figure 4** Installation plan of the pipe system "TERRAIN SDP STANDARD PVC, 110x3.2", mounted with clamps "sound proof support bracket" manufactured by REHAU (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 of February, 2005. 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  $m'' = 220 \text{ kg/m}^2$ ) 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)  $Q = 0.5 \text{ l/s}$ , corresponding to  $Q = 30 \text{ l/min}$ ,
- (2)  $Q = 1.0 \text{ l/s}$ , corresponding to  $Q = 60 \text{ l/min}$ ,
- (3)  $Q = 2.0 \text{ l/s}$ , corresponding to  $Q = 120 \text{ l/min}$ ,
- (4)  $Q = 4.0 \text{ l/s}$ , corresponding to  $Q = 240 \text{ l/min}$ .

Here, a flow rate of  $Q = 2.0 \text{ l/s}$  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  $Q_{\max} = 4 \text{ l/s}$  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 140-3:2005 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  $L_{p,A}$  and the structure-borne sound characteristic level  $L_{s,A}$  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  $L_{v1}$  according to DIN 52219 and DIN 4109.

## Evaluation of Measurements

### Stationary noise

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  $A_0 = 10 \text{ m}^2$  and A-weighted:

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

$L_{n,F}$	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	[m <sup>2</sup> ]
$V$	volume of test room	[m <sup>3</sup> ]
$T_n$	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.

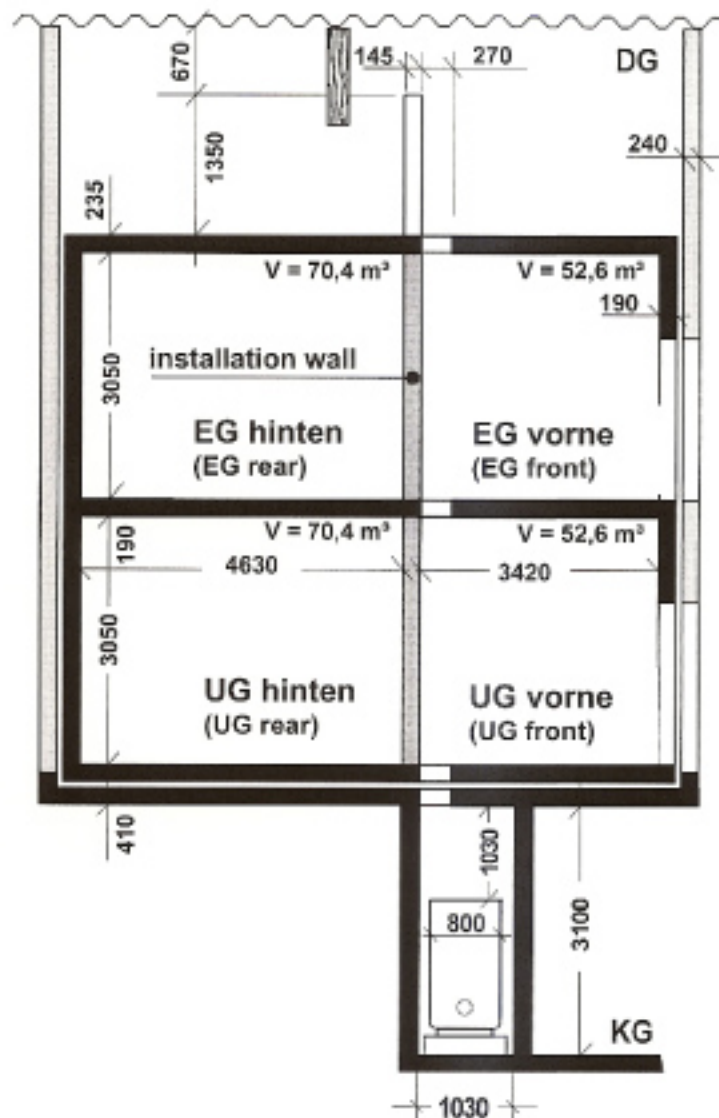
$$(2) \quad L_{AF,10} = 10 \cdot \lg \left( \sum_{n=1}^{18} 10^{\frac{L_{n,AF,10}}{10}} \right) \quad [\text{dB(A)}]$$

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 value ( $L_{AF,10}$ ) is used as the installation sound level  $L_n$  in the test facility.

### Noise variable with time

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 in the same place at a time interval of 0.125 s. The evaluation is performed in the same way as in the case of stationary noise, except for the background noise correction which is dropped. Subsequently, the maximum value ( $L_{AF,10,max}$ ) is determined from the time profile.





Sectional drawing of the installation test facility of the Fraunhofer Institute of Building Physics (dimensions given in mm). The test facility comprises two spaces each on 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 also possible to perform tests on installation systems which extend across several floors, e.g. waste-water installation systems. Both installation walls can be substituted according to actual requirements. In the standard case, single-leaf solid walls with a mass per unit area of  $220 \text{ kg/m}^2$  (according to German standard DIN 4109) are used. Since the sound insulation properties of these walls do not meet the requirements to be fulfilled by a wall separating different occupancies within the same building ( $R'_{w} \geq 53 \text{ dB}$ ), the next adjacent spaces to be protected from noise are located diagonally above or below the installation space (in case of a standard ground-plan design). 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 reverberation times are between 1 s and 2 s within the examined frequency range. The flanking parts, with an average mass per unit area of approximately  $440 \text{ kg/m}^2$ , are made of concrete.