

SG-Bauakustik

Institut für schalltechnische Produktoptimierung

Test Report

No. 1818-002-19 dated 01.07.2019

Improvement Factor of Pipe Clamps in the Test Stand

Client: J. van Walraven Holding B.V.
Industrieweg 5
3641 RK Mijdrecht
The Netherlands

Test Object: KSB2 two-screw-clamp with noise insulating inserts made of EPDM-rubber on measuring tubes ½", 1", 2", 4" and 6"

Contract: Ascertainment of the improvement factor of the noise of sanitary piping by installing decoupling pipe clamps in accordance with DIN EN ISO 3822-1

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1. Definition of Project and General Details

1.1 Definition of project

J. van Walraven Holding B.V., Mijdrecht, Netherlands, produces and sells amongst other things different types of pipe clamps with noise insulating inserts. In terms of product specifications, the KSB2 two-screw-clamp with noise insulating inserts made of EPDM-rubber on measuring tubes in the nominal sizes ½", 1", 2", 4" and 6" is to be tested. This product is a two-piece clamp made of steel with two locking screws, which are screwed on one side directly into the clamp and on the opposite side in a firmly inserted in plastic holder nut.

The pipe clamps are fitted on an M8/M10 nut welded to the pipe clamp that is bolted into an appropriate threaded rod (M10) which in turn is fixed with a corresponding metal anchor to the ground in order to ascertain the improvement measurement.

Noise insulating inserts made of EPDM-rubber with side couplers are inserted in the pipe clamps for decoupling the impact sound in order by these means to prevent a metal interconnection between clamp and pipe.

For measuring, the locking bolts were tightened so that the measuring tube could still just be manually turned (test situation which describes the usual installation).

Five measurements were carried out:

Measurement 1: KSB2 two-screw-clamp, ½" (20 - 23 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm)

Measurement 2: KSB2 two-screw-clamp, 1" (31 - 35 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm)

Measurement 3: KSB2 two-screw-clamp, 2" (60 - 64 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm)

Measurement 4: KSB2 two-screw-clamp, 4" (108 - 115 mm), connection M8/10, with EPDM-rubber (23 x 4,20 mm)

Measurement 5: KSB2 two-screw-clamp, 6" (165 - 169 mm), connection M8/10, with EPDM-rubber (25 x 4,00 mm)

1.2 General description

More or less intensive structure-borne noise oscillation occurs in water supply lines of plumbing installations as a consequence of cavitation effects which occur when using tap fittings. This structure-borne noise is transmitted backwards via the supplied water and the walls of the pipes whereby noise stimulus of the structure can occur when there is rigorous contact to the pipe system.

The development of structure-borne noise can be sustainably reduced through the suitable formation of tap fittings in combination with a limitation of the tap amount. In accordance with DIN EN ISO 3822-1 it is measured that premium quality tap fittings which by means of a thin wall (required area related minimum density, $m' \geq 220 \text{ kg/m}^2$) the transmitted sound level can be reduced from the original $L_{AF} = 45 \text{ dB(A)}$ as follows:

Fitting group I:	L_{ap}	\leq	20 dB(A)
Improvement measurement:	ΔL_{IN}	\geq	25 dB(A)
Fitting group II:	L_{ap}	\leq	30 dB(A)
Improvement measurement:	ΔL_{IN}	\geq	15 dB(A)

Basis for the evaluations are:

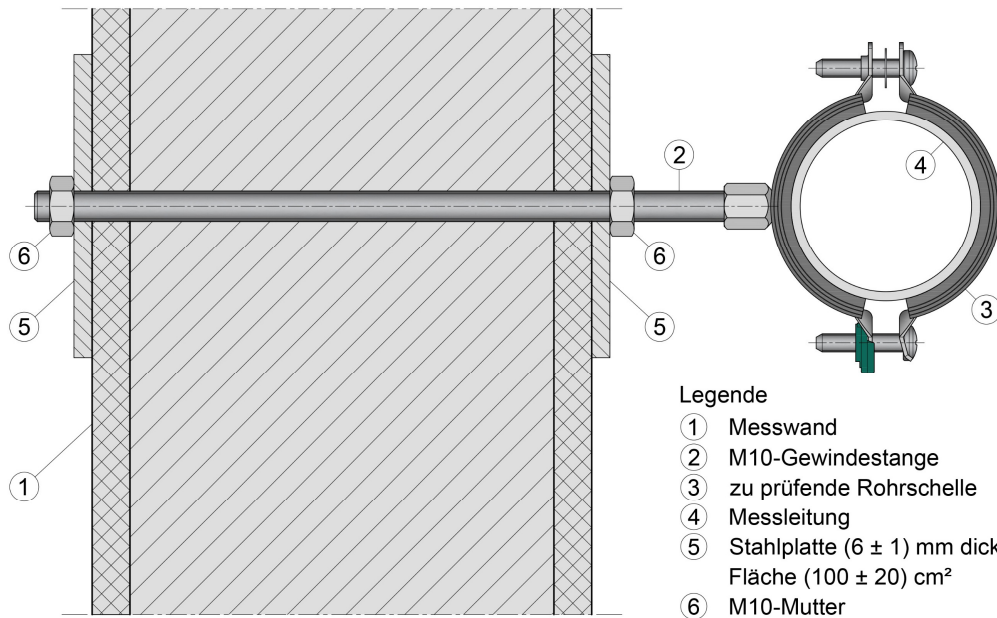
- 1: Application of a loud installation noise norm (IGN) in accordance with DIN-EN-ISO-3822-1 as reference source.
- 2: Measurement of noise transmission at a flow pressure of 0,3 MPa (3 bar) in the mid-band frequency of the octave bands of $f = 125$ to 4.000 Hz and calculation of the A-sound level in decibel according to DIN 60 651.
- 3: Generating the noise in a 1" steel pipe directly sealed with installation noise normal (IGN), outer diameter $d = 33,7 \text{ mm}$, nominal width $d = 25 \text{ mm}$ and/or a measuring pipe which is suitable for the pipe clamp to be tested.
- 4: Fastening the slightly in flow direction raised pipe with four clamps on thin masonry partition, thickness $d = 11,5 \text{ cm}$ made of brick material, rendered on both sides, whereby the surface related mass of the wall is:

$$m' = 100 \dots 250 \text{ kg/m}^2$$

The type of fastening can be seen in the following diagram.

Diagram (Drawing of the client, Measurement 1 to 5):

Schematic diagram of the fastening of a measurement line on the test stand in accordance with DIN EN ISO 3822-1



Depending on the equipment of the pipe clamp, fastening can also be carried out with an M - 10 threaded rod with a suitable nut.

5. Conversion of the noise level occurring in the measuring room behind the measuring wall on the relevant absorption area

$$A_0 = 10 \text{ m}^2.$$

In accordance with the above-mentioned explanation, the relevant standards for noise insulation ensured that low-priced acoustic fittings are developed and marked accordingly. However, this did not, as initially presumed, lead to disturbance caused by line noise being eliminated.

Reasons for further disturbances are:

- The desired noise reduction to

$$\Delta L_{IN} \geq 15 \text{ dB(A)}$$

cannot be brought about when there are larger specific draw-off quantities, for example with flush valves, therefore no test certificate can be acquired.

- With unfavourable, beyond the contact of the fastening clamps exceeding the connection between the pipe and the structure, for example by means of plastering, greater noise emission occurs than required by the relevant standards.
- With recesses and slits in the walls for laying pipes and using thin cover casings in direct contact with the pipe line system, greater noise emissions than stipulated in the relevant standards also occur.
- Especially in the noise-sensitive night-time, the substantially lower water withdrawal from the overall network leads to correspondingly higher tap pressures than 0,3 MPa so that all pipe line noise emissions increase accordingly.
- Due to the above-mentioned criteria, pipe lines for sanitation installations are nowadays, as a matter of principle, separated from the structure by a structure-borne noise decoupler. Special pipe clamps on the fastening points are used for this. Such a clamp was to be tested within the scope of this test report.

Based on experience, for the sound levels of a water supply system installed and tested following DIN EN ISO 3822-1 a distinct reduction of noise exposure can be achieved with such clamps. In addition to the use of suitable clamps, plastered pipe lines should be encased with soft, elastic insulating materials before grouting. The system consisting of pipe lines and tap appliances should accordingly be laid 'floating'.

1.3 Measuring standards

The measurements were carried out according to the following regulations

- DIN EN ISO 3822-1 (July 2009)
Acoustics – Laboratory tests on noise emission from appliances and equipment used in water supply installations –
Part 1: Method of measurement” (ISO 3822-1:1999 + Amd. 1:2008);
German Version EN ISO 3822-1:1999 + A1:2008

1.4 Manufacturer of test arrangement

SG-Bauakustik
Mainstraße 15
45478 Mülheim an der Ruhr

1.5 Client requesting tests

J. van Walraven Holding B.V.
Industrieweg 5
3641 RK Mijdrecht
The Netherlands

2. Measuring Arrangement and Assessment Principles

A ½”-, 1”-, 2”-, 4”- and/or 6”-measuring pipe was laid in each of the clamp configurations to be tested and fastened by tightly connecting the clamp halves as described above. Four (1” and 6”) and three (½”, 2” and 4”) pipe clamps respectively of the type described were used with threaded rods and the respective metal plugs to connect the installation test stand with the wall in accordance with DIN EN ISO 3822-1. The following measuring pipes were used:

½”:	copper pipe, 22,0 mm
1”:	steel pipe, 33,7 mm
2”:	steel pipe, 60,3 mm
4”:	steel pipe, 114,3 mm
6”:	steel pipe, 165,1 mm

For the reference measurement, the measuring tube was fixed with clamps without EPDM-rubber (½”: BIS HD500 19-23, 1”: BIS HD500 31-36, 2”: BIS HD500 59-65, 4”: BIS HD500 108-116, 6”: BIS HD500 159-169).

3. Execution of Measuring

In order to ascertain the improvement of the test object, the supply of mains water was carried out from a booster station via a 1" thick hose to the measuring line fastened to the test wall of measuring room. The flow pressure was ascertained in compliance with the standard directly at the tap source. An installation noise normal (IGN) served as tap source in accordance with DIN EN ISO 3822-1. The determination of the noise level in the diffuse noise field of the measuring room was carried out via an evaluation filter in accordance with DIN EN 60 651 by averaging the received values from three measurements in each case. Apart from the transmission values when using the measuring line, also the extraneous noises and the inherent noises of the installation equipment affecting the measuring room were ascertained at the octave centre frequencies. These values were sufficiently low so that no corrections entered.

The level reduction by applying the clamps to be tested, are calculated after deducting the difference from "rigid" and "decoupled" fastening of the line from the reference value of the IGN octave sound level.

4. Measuring Results

The results for the tested arrangements can be seen in the enclosures 2 to 6 of this report. In conclusion the tested configurations give the values listed in the following tables 1 to 3. It means:

- Measurement 1:** KSB2 two-screw-clamp, 1/2" (20 - 23 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm), Enclosure 2
- Measurement 2:** KSB2 two-screw-clamp, 1" (31 - 35 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm), Enclosure 3
- Measurement 3:** KSB2 two-screw-clamp, 2" (60 - 64 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm), Enclosure 4
- Measurement 4:** KSB2 two-screw-clamp, 4" (108 - 115 mm), connection M8/10, with EPDM-rubber (23 x 4,20 mm), Enclosure 5
- Measurement 5:** KSB2 two-screw-clamp, 6" (165 - 169 mm), connection M8/10, with EPDM-rubber (25 x 4,00 mm), Enclosure 6

Table 1: Measuring values from 19.06.2019

Centre Frequency of Octave band f in Hz	125	250	500	1000	2000	4000	Mean value
Reverb. Time in V = 74.3 m ³ large measuring room T in s	2,29	1,46	1,09	1,14	1,21	1,16	T _m = 1,39 s
Extraneous noise level in measuring room when carrying out tests L _b in dB	23,8	19,3	9,9	8,5	9,0	10,0	--
Correction in dB	- 16,1	- 8,6	- 3,1	± 0,0	+ 1,2	+ 1,0	
A-valued level in dB	7,7	10,7	6,8	8,5	10,2	11,0	17,2 dB(A)
Reference Value							
Sound level in measuring room when fastening the measuring pipe with rigid pipe clamps, L _{s,starr} in dB							
Meas. pipe: Copper pipe, ½"	63,4	62,5	63,8	64,1	55,6	50,8	--
Meas. pipe: Steel pipe, 1"	61,1	61,8	62,9	64,1	54,6	51,1	--
Meas. pipe: Steel pipe, 2"	57,6	56,9	61,7	62,1	52,1	48,3	
Meas. pipe: Steel pipe, 4"	56,9	56,3	62,3	61,9	51,2	47,2	
Meas. pipe: Steel pipe, 6"	57,6	56,1	60,6	60,3	50,4	46,9	--
Meas. values test objects							
Sound level in measuring room when fastening the measuring pipe with decoupled pipe clamps, L _{s,entk.} in dB,							
Measurement 1	46,8	53,3	44,9	47,2	38,6	25,9	--
Measurement 2	42,9	37,1	43,5	45,4	39,0	22,5	--
Measurement 3	40,2	38,6	44,5	40,4	29,6	18,8	--
Measurement 4	35,0	27,8	41,5	41,7	27,9	15,4	--
Measurement 5	37,8	29,6	45,3	40,9	24,9	12,9	--

Table 2: Improvement factors

Centre Frequency of Octave band f in Hz	125	250	500	1000	2000	4000	Mean Value
Improvement measuring rigid to decoupled fastening L _{IN} = L _{s,starr} - L _{s,entk.} in dB							
Measurement 1	16,6	9,2	18,9	16,9	17,0	24,9	--
Measurement 2	18,2	24,7	19,4	18,7	15,6	28,6	--
Measurement 3	17,4	18,3	17,2	21,7	22,5	29,5	--
Measurement 4	21,9	28,5	20,8	20,2	23,3	31,8	--
Measurement 5	19,8	26,5	15,3	19,4	25,5	34,0	--

Table 3: Relation of improvement factors to the standard guidelines

Centre frequency of the Octave band f in Hz	125	250	500	1000	2000	4000	Mean Value
Ref. value for IGN, L_{sm} in dB	35,0	39,0	42,0	42,0	37,0	25,0	--
Correction in dB	- 16,1	- 8,6	- 3,1	$\pm 0,0$	+ 1,2	+ 1,0	--
A-valued sound level in dB	18,9	30,4	38,9	42,0	38,2	26,0	45,0 dB(A)
Sound level in relation to standard guidelines, $L = L_{sm} - L_{IN}$ in dB							
Measurement 1	18,4	29,8	23,1	25,1	20,0	0,1	--
A- valued sound level in dB	2,3	21,2	20,0	25,1	21,2	1,1	28,4 dB(A)
Measurement 2	16,8	14,3	22,6	23,3	21,4	-3,6	--
A-valued sound level in dB	0,7	5,7	19,5	23,3	22,6	-2,6	26,9 dB(A)
Measurement 3	17,6	20,7	24,8	20,3	14,5	-4,5	--
A- valued sound level in dB	1,5	12,1	21,7	20,3	15,7	-3,5	24,9 dB(A)
Measurement 4	13,1	10,5	21,2	21,8	13,7	-6,8	--
A- valued sound level in dB	-3,0	1,9	18,1	21,8	14,9	-5,8	23,8 dB(A)
Measurement 5	15,2	12,5	26,7	22,6	11,5	-9,0	--
A- valued sound level in dB	-0,9	3,9	23,6	22,6	12,7	-8,0	26,3 dB(A)

When using the tested fastening configurations at a flow pressure of 0,3 MPa on a fitting measuring wall with standard compliant transmission sound levels of $L_{IN} = 45$ dB(A) during the evaluation, the improvement measurement amounted to:

Measurement 1: KSB2 two-screw-clamp, ½" (20 - 23 mm) **VM $L_{IN} = 17$ dB(A)**

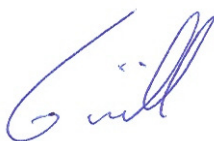
Measurement 2: KSB2 two-screw-clamp, 1" (31 - 35 mm) **VM $L_{IN} = 18$ dB(A)**

Measurement 3: KSB2 two-screw-clamp, 2" (60 - 64 mm) **VM $L_{IN} = 20$ dB(A)**

Measurement 4: KSB2 two-screw-clamp, 4" (108 - 115 mm) **VM $L_{IN} = 21$ dB(A)**

Measurement 5: KSB2 two-screw-clamp, 6" (165 - 169 mm) **VM $L_{IN} = 19$ dB(A)**

Mülheim an der Ruhr, 01.07.2019



Stefan Grill



Laszlo Pobloth

Fig. 1: Meas. 2: KSB2 two-screw-clamp, 1" (31 - 35 mm), connection M8/10, with EPDM-rubber (20 x 3,70 mm)



Fig. 2: Meas. 4: KSB2 two-screw-clamp, 4" (108 - 115 mm), connection M8/10, with EPDM-rubber (23 x 4,20 mm)



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Measurement of Water Appliance Noises in the Laboratory

Enclosure 2

according to DIN EN ISO 3822-1, 07.2009

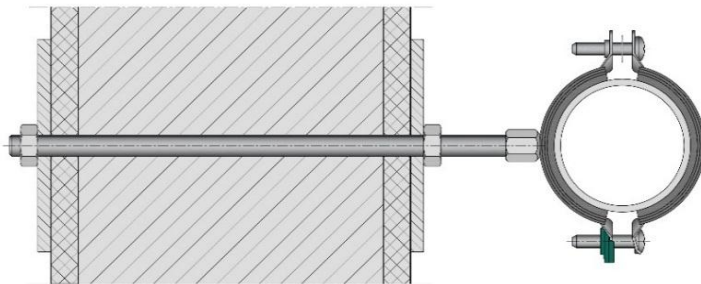
Client: J. van Walraven Holding B.V., Industrieweg 5, 3641 RK Mijdrecht, The Netherlands
 Test object: 1/2" copper pipe, outer dia d = 22,0 mm, fastened with KSB2 two-screw-clamp, connection M8/10, 1/2" (20 - 23 mm), with EPDM-rubber
 Operation: Withdrawal with IGN according to DIN EN ISO 3822-1 at flow pressure of 0.3 Mpa (3 bar)

Evaluation:

Measurement of the noise transmission at octave centre frequencies $f = 125$ to 4000 Hz and calculation of the difference between "rigid" and "decoupled" fastening, Evaluation using the normative IGN-reference values, conversion to the average expected noise transmission in the building. Measurement on 19.06.2019, air temperature in test stand: $20,4$ °C, relative humidity: $51,3$ %

Measurement 1

Schematic diagram for build-up of test object:

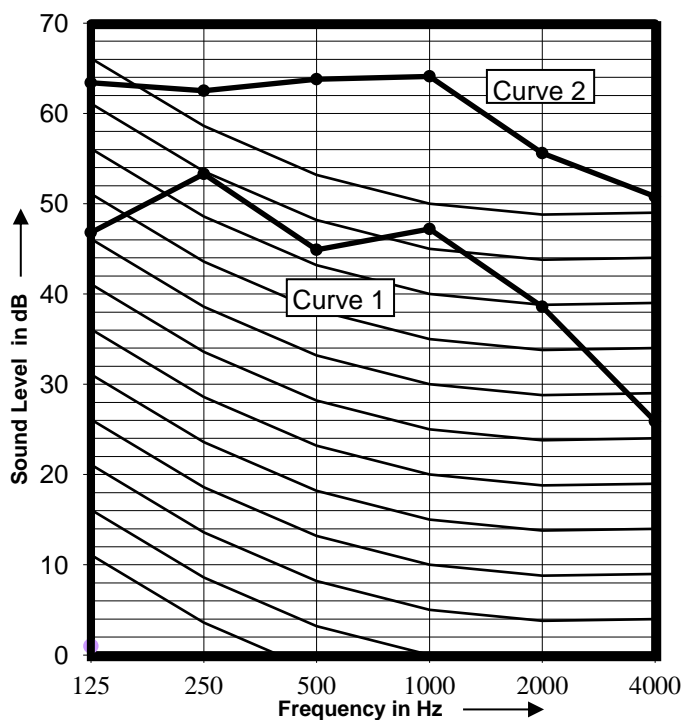


Test Criteria:

Volume test room: $V = 74,3$ m³
 Aver. reverb. time: $\bar{T}_N = 1,39$ s
 Area measuring wall: $F = 8,20$ m²
 Area density: $g_F = 232$ kg/m²
 Length measuring pipe: $L = 2,80$ m
 Outer diameter: $D = 22,0$ mm
 Flow pressure: $p = 0,30$ MPa

Decoupling insert: EPDM (20 x 3,70 mm)

Measuring diagram:



Evaluation:

Curve 1: Noise transmission with fastening with pipe clamp type see above

$L_{IN} = 28$ dB(A)

Curve 2: Noise transmission when using rigid fastening

$L_{IN} = 45$ dB(A)

Improvement:

Frequency f [Hz]	125	250	500	1000	2000	4000
VM L_{IN} [dB]	16,6	9,2	18,9	16,9	17,0	24,9

A-Evaluation $L_{IN} = 17$ dB(A)

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according to DIN EN ISO 3822-1, 07.2009

Enclosure 3

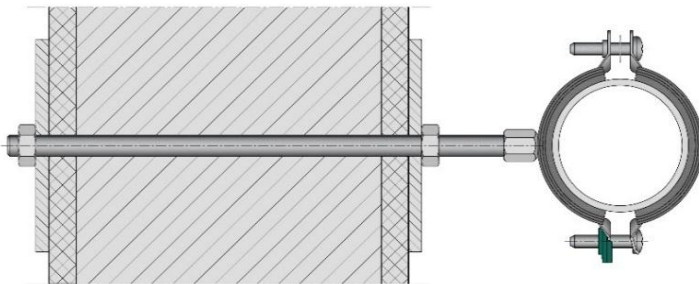
Client: J. van Walraven Holding B.V., Industrieweg 5, 3641 RK Mijdrecht, The Netherlands
 Test object: 1" steel pipe, outer dia d = 33,7 mm, fastened with KSB2 two-screw-clamp, connection M8/10, 1" (31 - 35 mm), with EPDM-rubber
 Operation: Withdrawal with IGN according to DIN EN ISO 3822-1 at flow pressure of 0.3 Mpa (3 bar)

Evaluation:

Measurement of the noise transmission at octave centre frequencies $f = 125$ to 4000 Hz and calculation of the difference between "rigid" and "decoupled" fastening, Evaluation using the normative IGN-reference values, conversion to the average expected noise transmission in the building. Measurement on 19.06.2019, air temperature in test stand: $20,4$ °C, relative humidity: $51,3$ %

Measurement 2

Schematic diagram for build-up of test object:

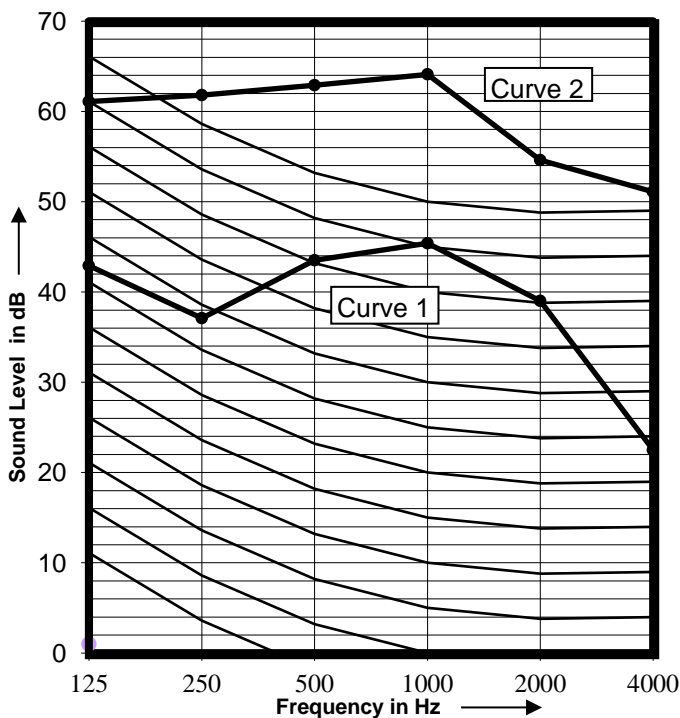


Test Criteria:

Volume test room: $V = 74,3$ m³
 Aver. reverb. time: $\bar{T}_N = 1,39$ s
 Area measuring wall: $F = 8,20$ m²
 Area density: $g_F = 232$ kg/m²
 Length measuring pipe: $L = 3,20$ m
 Outer diameter: $D = 33,7$ mm
 Flow pressure: $p = 0,30$ MPa

Decoupling insert: EPDM (20 x 3,70 mm)

Measuring diagram:



Evaluation:

Curve 1: Noise transmission with fastening with pipe clamp type see above

$L_{IN} = 27$ dB(A)

Curve 2: Noise transmission when using rigid fastening

$L_{IN} = 45$ dB(A)

Improvement:

Frequency f [Hz]	125	250	500	1000	2000	4000
VM L_{IN} [dB]	18,2	24,7	19,4	18,7	15,6	28,6

A-Evaluation $L_{IN} = 18$ dB(A)

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Measurement of Water Appliance Noises in the Laboratory

Enclosure 4

according to DIN EN ISO 3822-1, 07.2009

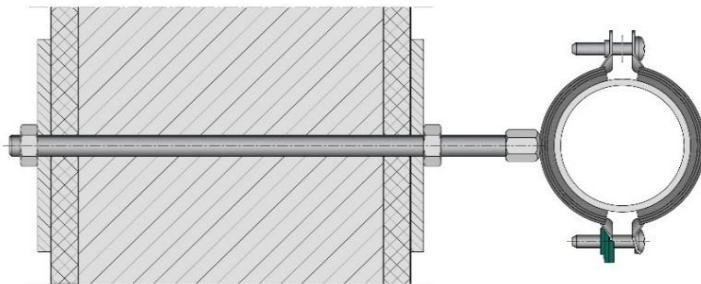
Client: J. van Walraven Holding B.V., Industrieweg 5, 3641 RK Mijdrecht, The Netherlands
 Test object: 2" steel pipe, outer dia d = 60,3 mm, fastened with KSB2 two-screw-clamp, connection M8/10, 2" (60 - 64 mm), with EPDM-rubber
 Operation: Withdrawal with IGN according to DIN EN ISO 3822-1 at flow pressure of 0.3 Mpa (3 bar)

Evaluation:

Measurement of the noise transmission at octave centre frequencies $f = 125$ to 4000 Hz and calculation of the difference between "rigid" and "decoupled" fastening, Evaluation using the normative IGN-reference values, conversion to the average expected noise transmission in the building. Measurement on 19.06.2019, air temperature in test stand: $20,4$ °C, relative humidity: $51,3$ %

Measurement 3

Schematic diagram for build-up of test object:

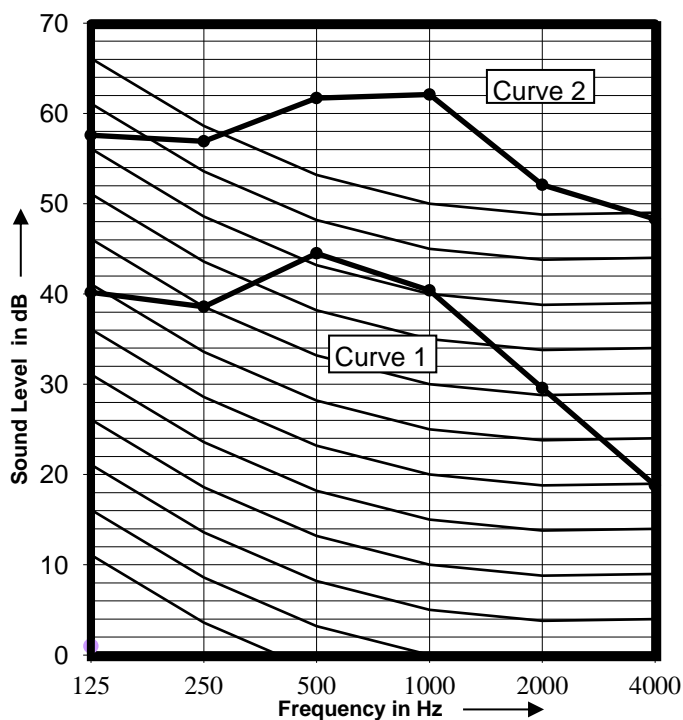


Test Criteria:

Volume test room: $V = 74,3$ m³
 Aver. reverb. time: $\bar{T}_N = 1,39$ s
 Area measuring wall: $F = 8,20$ m²
 Area density: $g_F = 232$ kg/m²
 Length measuring pipe: $L = 2,80$ m
 Outer diameter: $D = 60,3$ mm
 Flow pressure: $p = 0,30$ MPa

Decoupling insert: EPDM (20 x 3,70 mm)

Measuring diagram:



Evaluation:

Curve 1: Noise transmission with fastening with pipe clamp type see above

$L_{IN} = 25$ dB(A)

Curve 2: Noise transmission when using rigid fastening

$L_{IN} = 45$ dB(A)

Improvement:

Frequency f [Hz]	125	250	500	1000	2000	4000
VM L_{IN} [dB]	17,4	18,3	17,2	21,7	22,5	29,5

A-Evaluation $L_{IN} = 20$ dB(A)

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Enclosure 5

according to DIN EN ISO 3822-1, 07.2009

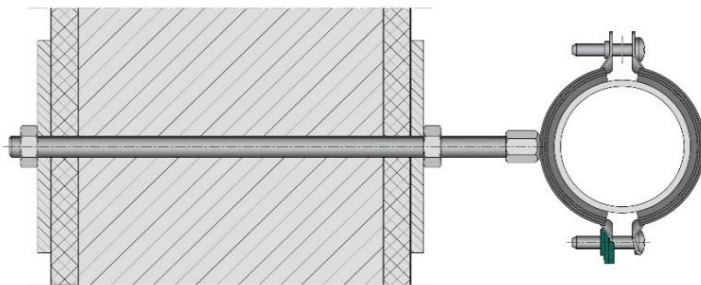
Client: J. van Walraven Holding B.V., Industrieweg 5, 3641 RK Mijdrecht, The Netherlands
 Test object: 4" steel pipe, outer dia d = 114,3 mm, fastened with KSB2 two-screw-clamp, connection M8/10, 4" (108 - 115 mm), with EPDM-rubber
 Operation: Withdrawal with IGN according to DIN EN ISO 3822-1 at flow pressure of 0.3 Mpa (3 bar)

Evaluation:

Measurement of the noise transmission at octave centre frequencies $f = 125$ to 4000 Hz and calculation of the difference between "rigid" and "decoupled" fastening, Evaluation using the normative IGN-reference values, conversion to the average expected noise transmission in the building. Measurement on 19.06.2019, air temperature in test stand: $20,4$ °C, relative humidity: $51,3$ %

Measurement 4

Schematic diagram for build-up of test object:

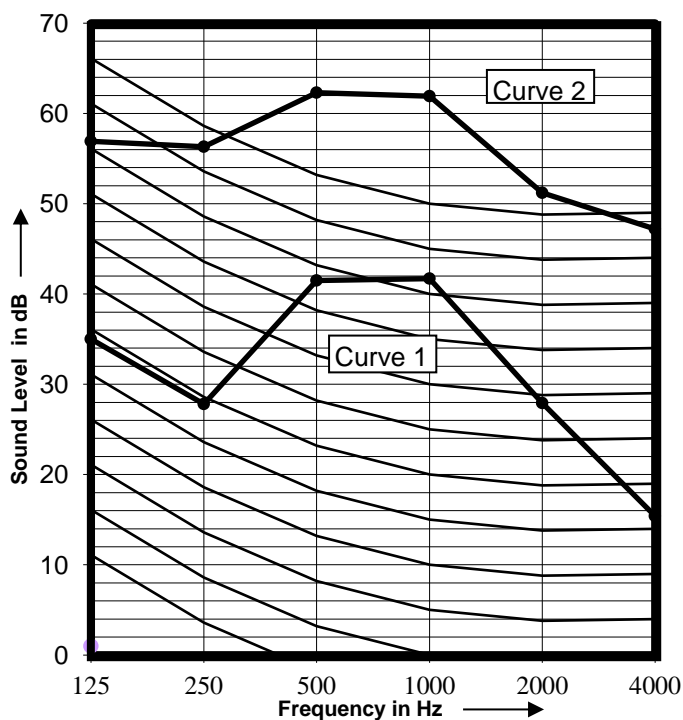


Test Criteria:

Volume test room: $V = 74,3$ m³
 Aver. reverb. time: $\bar{T}_N = 1,39$ s
 Area measuring wall: $F = 8,20$ m²
 Area density: $g_F = 232$ kg/m²
 Length measuring pipe: $L = 2,80$ m
 Outer diameter: $D = 114,3$ mm
 Flow pressure: $p = 0,30$ MPa

Decoupling insert: EPDM (23 x 4,20 mm)

Measuring diagram:



Evaluation:

Curve 1: Noise transmission with fastening with pipe clamp type see above

$L_{IN} = 24$ dB(A)

Curve 2: Noise transmission when using rigid fastening

$L_{IN} = 45$ dB(A)

Improvement:

Frequency f [Hz]	125	250	500	1000	2000	4000
VM L_{IN} [dB]	21,9	28,5	20,8	20,2	23,3	31,8

A-Evaluation $L_{IN} = 21$ dB(A)

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Measurement of Water Appliance Noises in the Laboratory

Enclosure 6

according to DIN EN ISO 3822-1, 07.2009

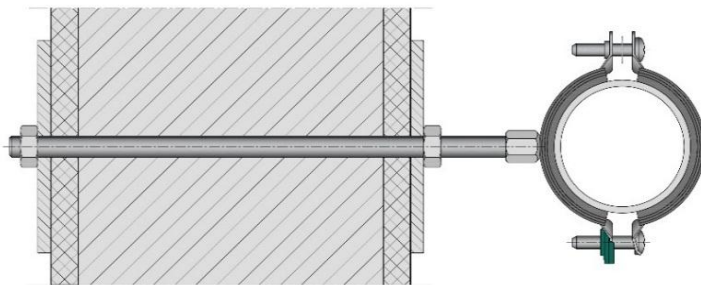
Client: J. van Walraven Holding B.V., Industrieweg 5, 3641 RK Mijdrecht, The Netherlands
 Test object: 6" steel pipe, outer dia d = 165,1 mm, fastened with KSB2 two-screw-clamp, connection M8/10, 6" (165 - 169 mm), with EPDM-rubber
 Operation: Withdrawal with IGN according to DIN EN ISO 3822-1 at flow pressure of 0.3 Mpa (3 bar)

Evaluation:

Measurement of the noise transmission at octave centre frequencies $f = 125$ to 4000 Hz and calculation of the difference between "rigid" and "decoupled" fastening, Evaluation using the normative IGN-reference values, conversion to the average expected noise transmission in the building. Measurement on 19.06.2019, air temperature in test stand: $20,4$ °C, relative humidity: $51,3$ %

Measurement 5

Schematic diagram for build-up of test object:

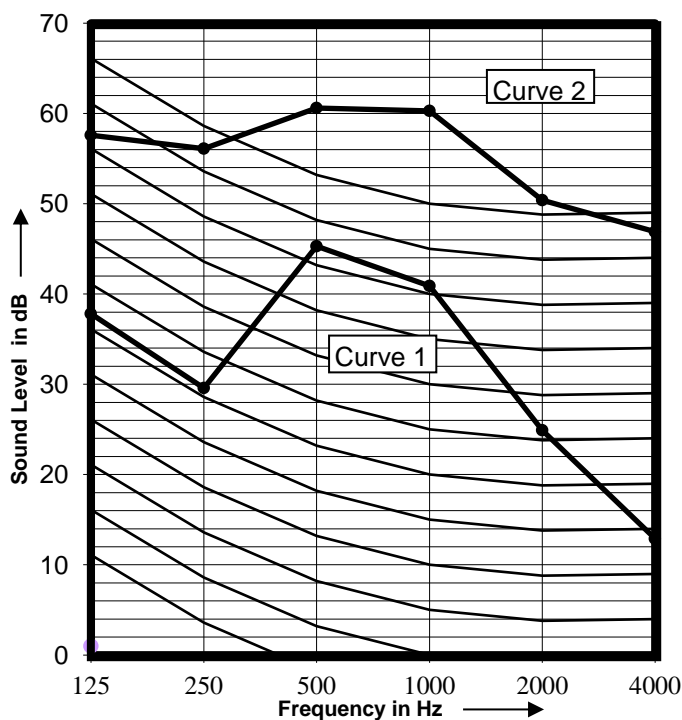


Test Criteria:

Volume test room: $V = 74,3$ m³
 Aver. reverb. time: $\bar{T}_N = 1,39$ s
 Area measuring wall: $F = 8,20$ m²
 Area density: $g_F = 232$ kg/m²
 Length measuring pipe: $L = 3,20$ m
 Outer diameter: $D = 165,1$ mm
 Flow pressure: $p = 0,30$ MPa

Decoupling insert: EPDM (25 x 4,00 mm)

Measuring diagram:



Evaluation:

Curve 1: Noise transmission with fastening with pipe clamp type see above

$L_{IN} = 26$ dB(A)

Curve 2: Noise transmission when using rigid fastening

$L_{IN} = 45$ dB(A)

Improvement:

Frequency f [Hz]	125	250	500	1000	2000	4000
VM L_{IN} [dB]	19,8	26,5	15,3	19,4	25,5	34,0

A-Evaluation $L_{IN} = 19$ dB(A)

No. of Test Report: 1818-002-19
 SG-Bauakustik
 Institut für schalltechnische Produktoptimierung
 Mainstrasse 15
 45478 Mülheim an der Ruhr, 01.07.2019

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