RAPPORT
utfärdad av ackrediterat provningslaboratorium

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Insertion loss of noise absorbing pipes according to SS-EN ISO 7235:2003 (English version of report 5P05742 rev 1 ”Bestämning av insättningsdämpning hos ljudabsorberande rör enligt SS-EN ISO 7235:2003”)

Revision: *The revision consists of the text: "Allegedly, the inside foil was perforated"*

Customer

Climate Recovery AB

Test objects

Two different ventilation pipe / muffler with connection diameter of 125 mm and 200 mm respectively. The ducts consisted of mineral wool covered with foil. The ducts had a circular exterior and an 6-sided interior.

Measured diameter of 125 mm pipe: mineral wool pipe Length: 2350 mm, total length of 2550 mm including connections. Outer Diameter: 190 mm, inner dimensions: 140 mm between the sides.

Measured diameter of 200mm pipe: mineral wool pipe Length: 2350 mm, total length of 2570 mm including connections. Outer Diameter: 280 mm, inner dimensions: 205 mm between the sides.

Date of measurement

2015 June 11th and September 22nd

Results

See table 1 and 2 for the insertion loss (D_i) values.
The results are only valid for the tested object.

Table 1 – Results in octave bands

	Insertion loss in decibel (dB) in octave bands in Hertz (Hz)							
	63	125	250	500	1000	2000	4000	8000
Pipe Ø125 mm	5	4	6	20	53	31	16	8
Pipe Ø200 mm	4	3	8	44	41	21	12	7

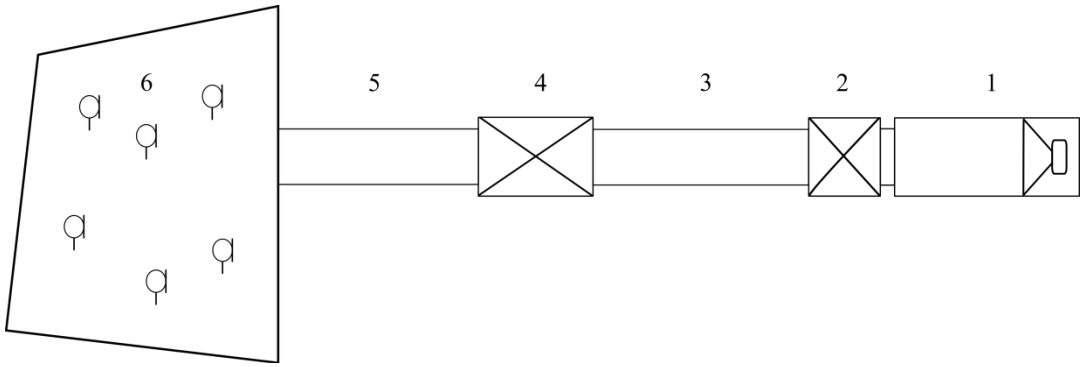
Table 2 – Results in 1/3 octave bands

Frequency (Hz)	Insertion loss(dB) Ø125 mm pipe	Insertion loss(dB) Ø200mm pipe
50	10,5	9,3
63	7,8	3,5
80	1,6	2,5
100	4,0	2,7
125	2,2	1,2
160	5,4	4,3
200	4,5	4,7
250	5,6	8,3
315	8,0	17,6
400	15,5	42,7
500	33,2	47,4
630	47,4	44,5
800	54,1	46,3
1000	54,9	45,8
1250	50,6	37,9
1600	47,7	30,3
2000	35,7	22,7
2500	26,9	18,1
3150	22,6	13,6
4000	17,8	11,9
5000	13,3	10,2
6300	8,6	7,3
8000	7,7	6,8
10000	7,6	6,1

Measurement setup

Figure 1 below shows the outline of the measurement arrangement in accordance with SS-EN ISO 7235: 2003 for the determination of insertion loss.

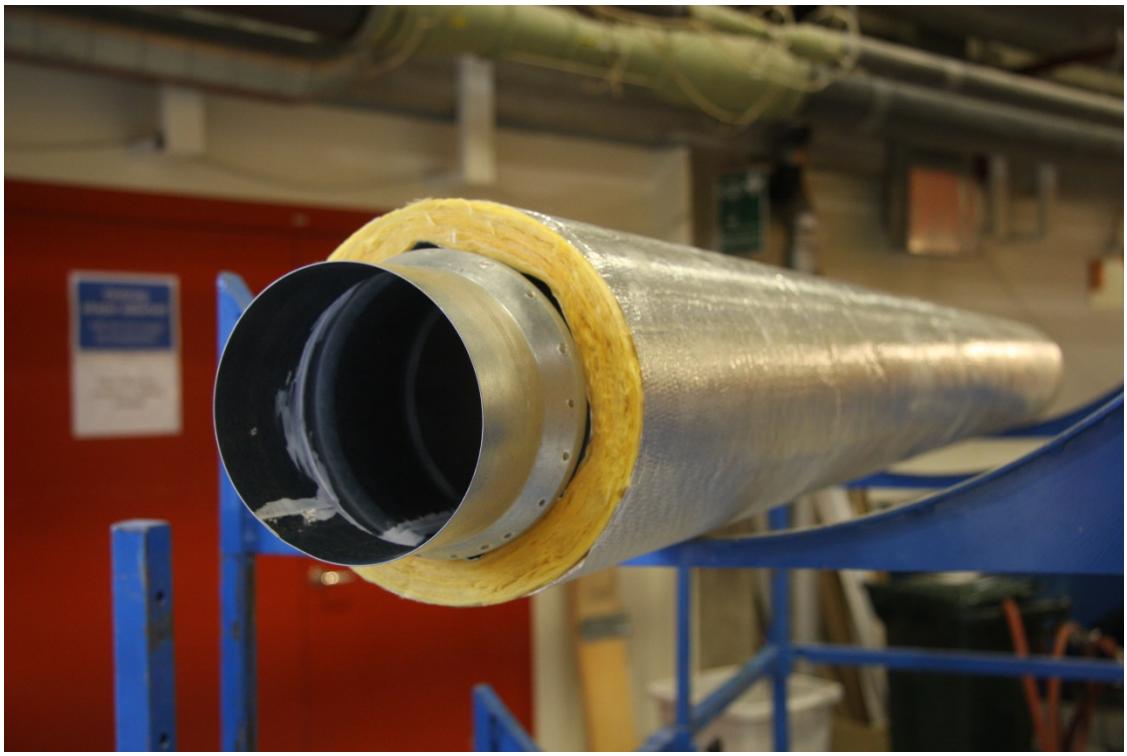
Figure 1 -Used measurement setup according to SS-EN ISO 7235



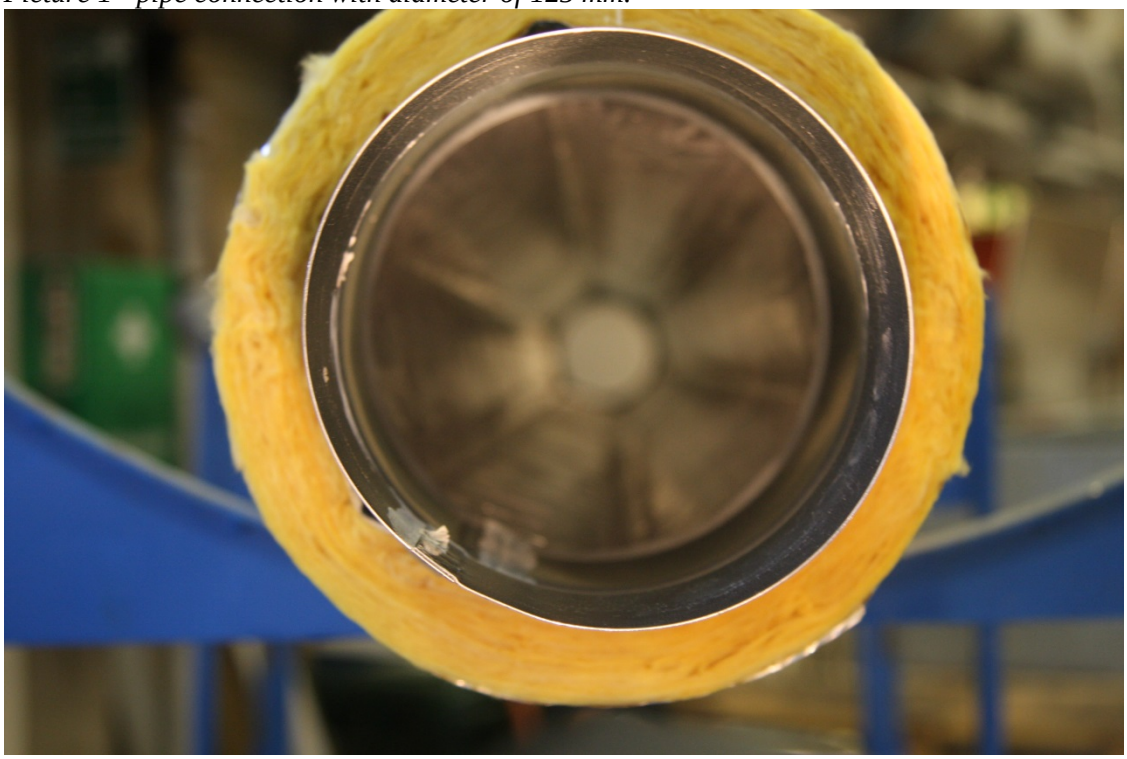
1. Pressure chamber with speakers.
2. Modal filters.
3. Circular duct Ø 125 and 200 mm, L = 3500 mm.
4. Silencer respectively compensation channel, L = 2500 mm.
5. Circular duct Ø 125 respectively 200 mm, L = 3500 mm.
6. Reverberation room, volume 200 m³.

As modal filter a silencer with circular connection Ø 400 mm with a length of 600 mm is used.

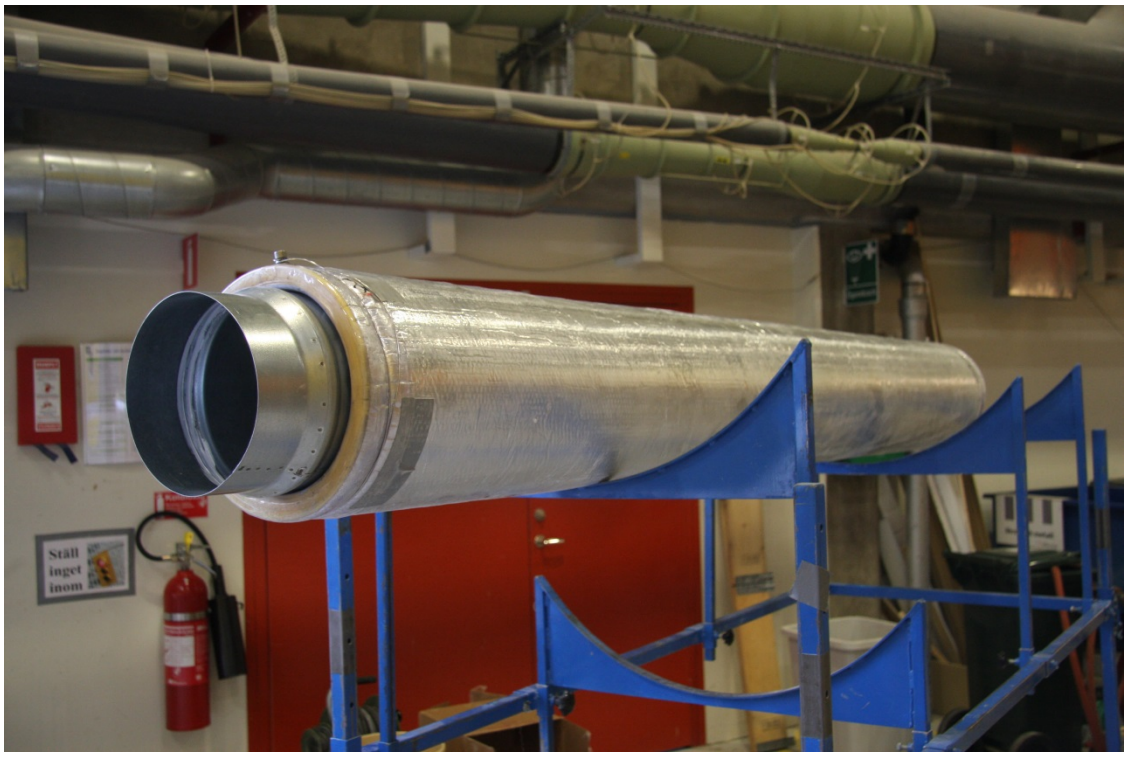
Pictures of test objects



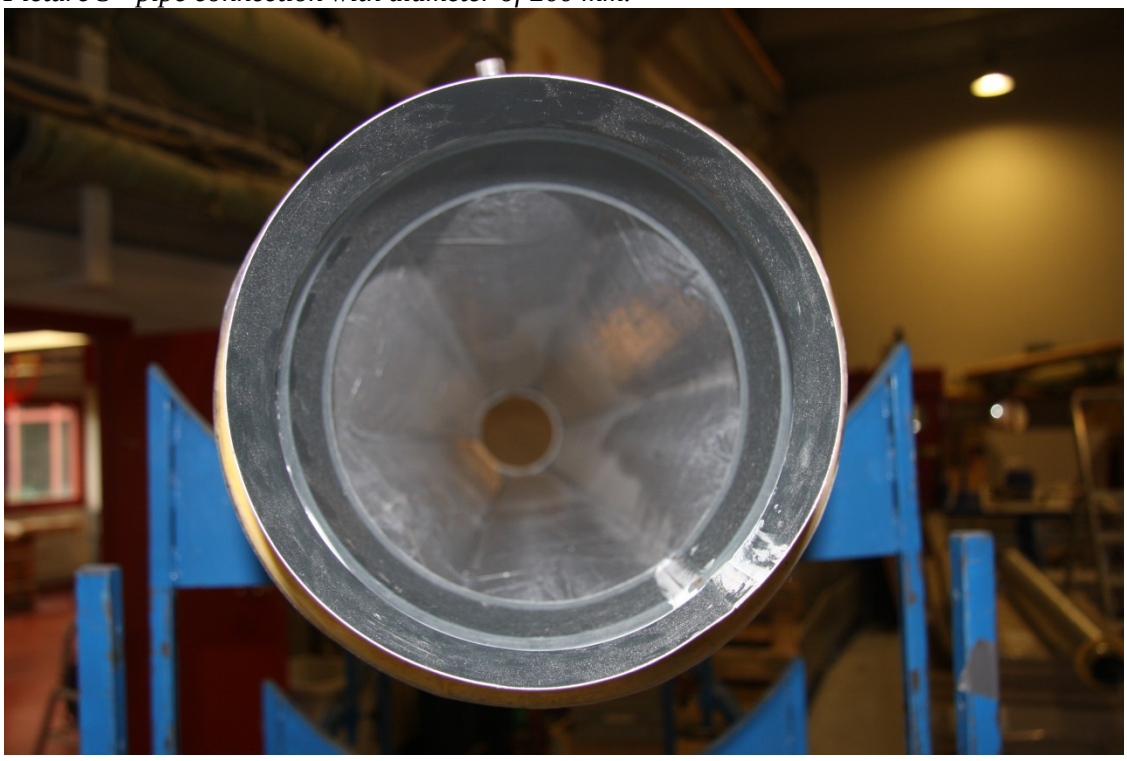
Picture 1 - pipe connection with diameter of 125 mm.



Picture 2 - pipe connection with diameter of 125 mm.



Picture 3 - pipe connection with diameter of 200 mm.



Picture 4 - pipe connection with diameter 200 mm.

Measurement method

Insertion loss

The measurement of insertion loss has taken place in accordance with SS-EN ISO 7235: 2003 "Acoustics - Measurement procedures for ducted silencers - Insertion loss", which means that the sound pressure level from a measuring rig, as shown in Figure 1 above, are registered with the muffler or the silencer replaced by a compensation channel.

Sound pressure levels are measured in six discrete microphone positions with an integration time of 30s for each microphone position. Sound pressure levels are measured in 1/3 octave bands 50-10000 Hz.

The measurements were made in a reverberation chamber with a volume of 200 m³ and total restriction area of 211 m² in 1/3-octave bands 50-10000 Hz. The standard is met except for the three 1/3 octave bands below 100 Hz because the standard stipulates a room volume> 200 m³. The insertion loss is obtained by the following:

$D = L_{p1} - L_{p2}$ $[dB]$

where

D = Insertion loss

L_{p1} = The sound pressure level in the reverberation room with the replacement duct.

L_{p2} = The sound pressure level in the reverberation room with silencer

Insertion loss in octave band is calculated as:

$$D_{1/1} = -10\lg\left(\frac{1}{3}\sum_{k=1}^{3}10^{-0,1D_{1/3,k}}\right)[dB]$$

where
$D_{1/3,k}$ is the insertion loss in each third octave band within the current octave band.

Limiting insertion loss

The limiting insertion loss that partly is a measure of the limitation of the measuring system are reported in Table 3 and were determined by fitting sound damping covers on the sides of the muffler. Mineral wool was placed in front of the lids.

Table 3 - Limiting insertion loss

Duct dimension	Limiting insertion loss in octave bands, (dB)							
	63	125	250	500	1000	2000	4000	8000
Pipe Ø125 mm	25	38	56	69	75	68	53	37
Pipe Ø200 mm	28	40	49	65	75	70	57	41

Table 4 – Limiting insertion loss in 1/3 octave bands.

Frequency (Hz)	Limiting insertion loss (dB) Pipe Ø125 mm	Limiting insertion loss (dB) Pipe Ø200 mm
50	29,5	27,6
63	21,4	26,2
80	28,8	36,7
100	40,3	42,6
125	34,7	39,4
160	44,9	39,3
200	54,0	46,0
250	56,1	53,0
315	58,6	49,2
400	70,1	62,1
500	66,9	66,5
630	73,1	73,1
800	74,8	75,0
1000	74,4	78,3
1250	75,7	73,2
1600	70,6	69,3
2000	69,4	69,7
2500	65,4	70,0
3150	62,3	66,6
4000	52,7	56,9
5000	50,3	54,2
6300	39,6	44,4
8000	38,8	40,3
10000	38,8	39,2

Measurement uncertainty

According to ISO 7235: 2003 it is estimated that the standard deviation of reproducibility to be:

- 1.5 dB in 1/3-octave bands of 50 to 100 Hz
- 1 dB in 1/3-octave bands 125-500 Hz
- 2 dB in 1/3-octave bands 630-1250 Hz
- 3 dB in 1/3-octave bands 1600-10000 Hz

The expanded measurement uncertainty of 95% confidence level is obtained by multiplying the standard deviation by the coverage factor 2.

Equipment used

Instrument	Manufacturer	Type	Serial/SP nr.
Analysator	Norsonic	850	8501133
Microphone	Brüel & Kjaer	4943	BX32058
Microphone	Brüel & Kjaer	4943	503326
Microphone	Brüel & Kjaer	4943	503325
Microphone	Brüel & Kjaer	4943	503324
Microphone	Brüel & Kjaer	4943	203323
Microphone	Brüel & Kjaer	4943	s/n 2206278
Microphone preamplifier	Brüel & Kjaer	2619	502246
Microphone preamplifier	Brüel & Kjaer	2619	502244
Microphone preamplifier	Brüel & Kjaer	2619	502219
Microphone preamplifier	Brüel & Kjaer	2619	502217
Microphone preamplifier	Brüel & Kjaer	2619	502252
Microphone preamplifier	Brüel & Kjaer	2619	s/n 970968
Microphone-multiplexer	Brüel & Kjaer	5966	1878617
Microphone calibrator	Brüel & Kjaer	4230	1410947

SP Sveriges Tekniska Forskningsinstitut
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