

Laboratory for Acoustics



Determination of acoustical characteristics of flexible ducted silencers type SILENCERA.FS.P, manufacturer AFS



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1 Introduction

At the request of AFS Boru Sanayi A.S. based in Ankara (Turkey) sound measurements have been carried out in order to determine the acoustical characteristics of

**flexible ducted silencers
type SILENCERAFS.P
manufacturer AFS Boru Sanayi A.S.**

The measurements have been carried out in the Laboratory for Acoustics of Peutz bv, at Mook, The Netherlands (see figure 1).



For these type of measurements the Laboratory for Acoustics has been accredited by the Dutch Accreditation Council (RvA).

The RvA is member of the EA MLA (**EA MLA: European Accreditation Organisation MultiLateral Agreement**: <http://www.european-accreditation.org>).

EA: "Certificates and reports issued by bodies accredited by MLA and MRA members are considered to have the same degree of credibility, and are accepted in MLA and MRA countries."

2 Norms and guidelines

The measurements have been carried out according to the Quality Manual of the Laboratory for Acoustics as well as:

ISO 7235:2003 "Acoustics - Laboratory measurement procedures for ducted silencers and air-terminal units - Insertion loss, flow noise and total pressure loss"
N.A. *The norm ISO 7235 is within all countries of the European Union accepted as European Standard Norm EN ISO 7235:2003*

Other related norms:

ISO 3741:2010¹ Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms

ISO 5135:1997 Acoustics - Determination of sound power levels of noise from air-terminal devices, air-terminal units, dampers and valves by measurement in a reverberation room

N.A. *The norm ISO 5135 is within all countries of the European Union accepted as European Standard Norm EN ISO 5135:1997*

¹ According to this norm, the report should include all measured sound pressure levels. Because these figures are not relevant for judging the quality of the product being tested, but merely for judging the accuracy of the calculations, they have been omitted in this report. It is possible of course to reproduce those figures at any time if the principal requests this.

3 Tested construction

The data presented here have been received from the principal (as thickness foils) or obtained by own observations.

Measurements have been carried out on the following flexible ducted silencers:

SILENCERAFS.P

Composition from inside to outside

- micro perforated aluminium foil, thickness 70 μm , reinforced with metal wire
- 50 mm glasswool
- PE jacket, thickness 100 μm ,

Diameter (inner duct)

127 / 160 mm

Length

1,5 m



The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.

4 Measurements

4.1 Measurement setup

The measurements have been carried according to the reverberation room method as described in the norm ISO 7235.

4.2 Insertion Loss D_i

The specimens are mounted in an measuring duct as shown in figure 2.

Noise is introduced in the measuring duct using a loudspeaker system which is mounted at one end of this duct in ventilation room (6). The other end of the duct leads into the reverberation room (3). The sound pressure level in the reverberation room caused by the loudspeaker is measured in two situations:

- with the specimen to be tested installed in the measuring duct
- without the specimen. Instead of the specimen a substitution duct (dummy) with the same dimensions (length, diameter) is installed in the measuring duct

A microphone on a rotating boom is used in the reverberation room in order to measure the noise radiated from the measurement duct. The reverberation time of the room is also determined. From each set of measurements (sound pressure level and reverberation time) the sound power level L_w radiated into the reverberation room is calculated according to ISO 3741¹. The insertion loss D_i is now calculated as

$$D_i = L_{wII} - L_{wI} \quad (1)$$

in which:

L_{wI} is the level of the sound power in the frequencyband considered, radiating into the connected reverberation room when the test object is installed;

L_{wII} is the level of the sound power in the frequencyband considered, radiating into the connected reverberation room when the substitution duct replaces the test object.

The insertion loss is determined in third octave bands from 50 Hz to 10 kHz.

4.3 Transmission Loss D_t

The specimens are mounted in an measuring duct as shown in figure 3. Noise is introduced in the measuring duct using a loudspeaker system which is mounted at one end of this duct in ventilation room (6). The test duct is installed crossing the reverberation room, both ends of the pipe penetrating through the walls of the room. The penetrations have been sealed adequately. The opposite end of the pipe is terminated by means of a closed anechoic termination in room (2).

¹ For this type of measurements the Laboratory for Acoustics has been accredited by the Dutch Council for Accreditation (RvA) as a test laboratory, registration number L334.

The sound pressure level in the reverberation room caused by the loudspeaker is measured in two situations:

- with the specimen to be tested installed in the measuring duct in the reverberation room;
- without the specimen and a open test duct.

A microphone on a rotating boom is used in the reverberation room in order to measure the noise radiated from the measurement duct. The reverberation time of the room is also determined. From each set of measurements (sound pressure level and reverberation time) the sound power level L_w radiated into the reverberation room is calculated according to ISO 3741. The wall insulation D_t is now calculated as

$$D_t = L_{wII} - L_{wI} + D_{td} \quad (2)$$

in which:

- L_{wI} is the level of the sound power in the frequencyband considered, radiating into the connected reverberation room when the test object is installed;
- L_{wII} is the level of the sound power in the frequencyband considered, radiating into the connected reverberation room with the open end of the test duct
- D_{td} reflection coefficient at the open end of the duct

The transmission loss at the open end of a straight and rigid duct is calculated from

$$D_{td} = 10 \lg \left[1 + \frac{\Omega}{\left(\frac{4 \pi f \sqrt{S}}{c} \right)^2} \right] \text{ dB} \quad (3)$$

in which:

- Ω = the solid angle of radiation at the duct (here: $\Omega = 4\pi$)
- c = speed of sound in air (340 m/s)
- f = frequency [Hz]
- S = cross-sectional area of the duct opening in the measuring room [m²]

The wall insulation is determined in third octave bands from 50 Hz to 10 kHz.

4.4 Results measurements

4.4.1 Insertion Loss

The results of the measurements are summarized in table 4.1 and presented in detail in the figures in Annex 1 of this report.

t4.1 Insertion loss **SILENCERAFS.P**

INSERTION LOSS [dB]								
AFS nr.	27		28		29		30	
diameter	127 mm		127 mm		160 mm		160 mm	
length	1,5 m		1,5 m		1,5 m		1,5 m	
record nr.	#337		#338		#363		#364	
figure nr.	1.1		1.2		1.3		1.4	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
50	23,0		21,9		27,2		29,5	
63	20,2	20,1	19,9	20,3	22,0	23,4	22,2	24,3
80	18,4		19,5		22,6		23,9	
100	22,8		23,2		32,7		34,0	
125	21,1	23,4	20,6	23,2	26,5	30,0	25,0	29,0
160	32,0		31,5		37,2		35,9	
200	39,3		38,1		36,5		34,5	
250	38,5	38,2	38,2	37,8	36,7	35,4	34,9	34,2
315	37,0		37,1		33,7		33,4	
400	38,0		37,9		33,3		33,2	
500	39,1	38,5	39,4	38,6	36,0	35,1	35,5	34,7
630	38,6		38,7		36,7		35,9	
800	40,5		39,6		38,4		37,2	
1000	43,9	42,7	42,3	41,6	40,4	39,7	39,1	38,6
1250	45,3		44,2		40,6		40,0	
1600	39,2		40,5		36,9		40,8	
2000	35,6	35,0	36,8	35,8	37,2	30,5	39,6	29,5
2500	32,6		33,1		26,4		25,0	
3150	27,1		27,4		19,5		19,5	
4000	21,3	22,7	21,4	23,1	16,9	18,2	16,1	17,2
5000	21,8		22,4		18,5		16,8	
6300	23,6		25,0		17,6		17,1	
8000	19,9	19,4	19,9	20,3	15,6	15,4	15,0	14,5
10000	17,0		18,3		13,8		12,6	

4.4.2 Transmission Loss

The results of the measurements are summarized in table 4.2 and presented in detail in the figures in Annex 2 of this report.

t4.2 Transmission loss **SILENCERAFS.P**

TRANSMISSION LOSS [dB]								
AFS nr.	27		28		29		30	
diameter	127 mm		127 mm		160 mm		160 mm	
length	1,5 m		1,5 m		1,5 m		1,5 m	
record nr.	#495		#496		#518		#519	
figure nr.	2.1		2.2		2.3		2.4	
frequency [Hz]	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.	1/3 oct.	1/1 oct.
50	27,4		28,2		25,4		26,4	
63	22,9	24,6	23,4	24,1	22,6	23,6	22,8	24,1
80	24,7		22,6		23,2		23,7	
100	23,8		22,0		21,9		21,8	
125	19,5	21,1	16,9	18,7	16,5	17,5	16,6	17,1
160	21,1		18,5		16,1		15,3	
200	22,2		20,5		15,8		15,4	
250	22,1	17,6	21,1	17,0	15,5	14,6	15,9	14,5
315	14,0		13,6		13,0		12,9	
400	15,7		15,8		12,0		12,1	
500	14,3	14,9	14,0	14,8	11,9	11,9	12,4	12,2
630	14,7		14,7		11,8		12,1	
800	14,7		14,5		12,6		12,8	
1000	15,0	15,0	14,3	14,3	12,9	13,1	12,8	13,1
1250	15,2		14,1		14,0		13,8	
1600	16,9		16,2		15,8		15,1	
2000	17,7	17,7	17,4	17,1	16,2	16,2	14,8	15,2
2500	18,5		17,9		16,6		15,8	
3150	18,9		19,1		17,0		16,4	
4000	18,7	19,2	17,7	18,0	18,7	18,2	18,1	17,9
5000	20,0		17,5		19,4		19,7	
6300	21,7		18,2		20,0		21,0	
8000	23,3	23,1	21,4	20,2	21,9	21,4	23,4	22,7
10000	24,8		22,0		22,9		24,6	

The results as presented here relate only to the tested items and laboratory conditions as described in this report. The laboratory can make no judgement about the representativity of the tested samples. The test report ahead is valid as long as the tested constructions and/or materials are unchanged.



Th. Scheers
Laboratory Supervisor

This report contains 11 pages, 3 figures and 2 annexes.

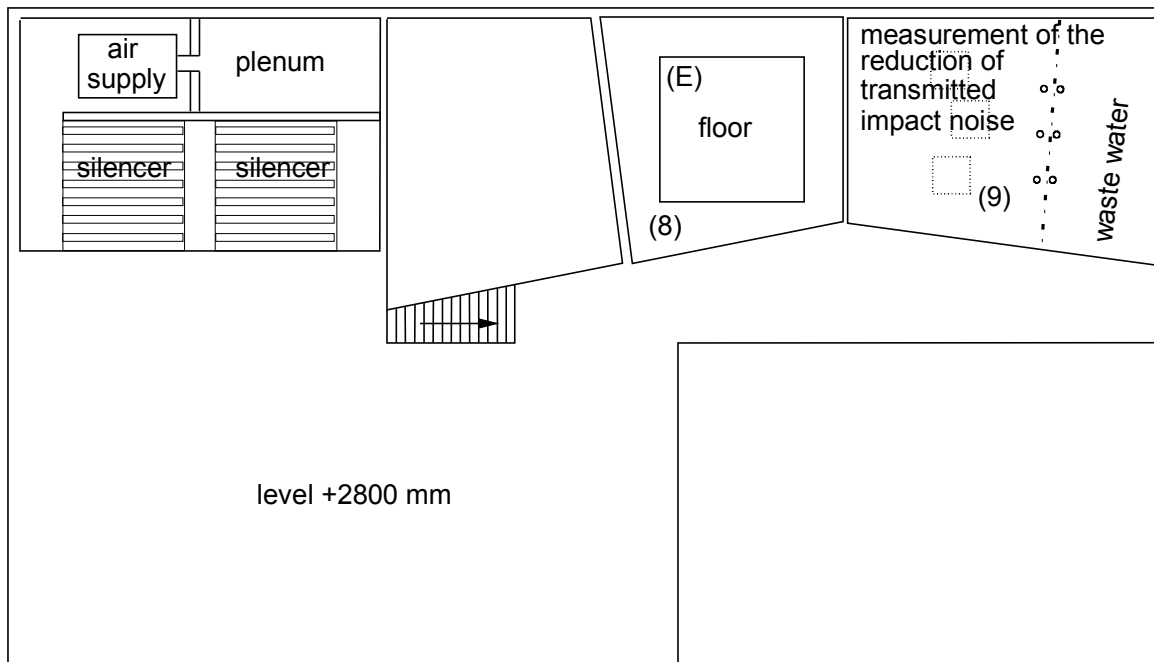


Mook,
ir. G.M.A. Perquin
Manager

PEUTZ bv
Lindenlaan 41, NL-6584 AC MOLENHOEK (LB), THE NETHERLANDS

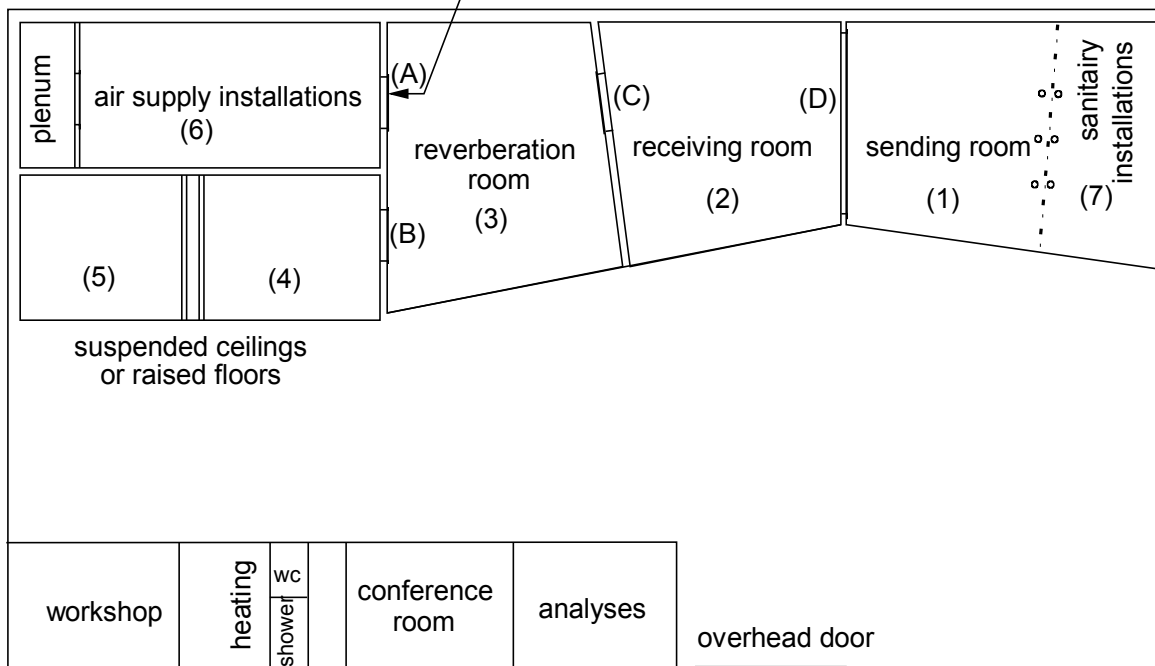
OVERVIEW

Story



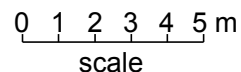
Ground level

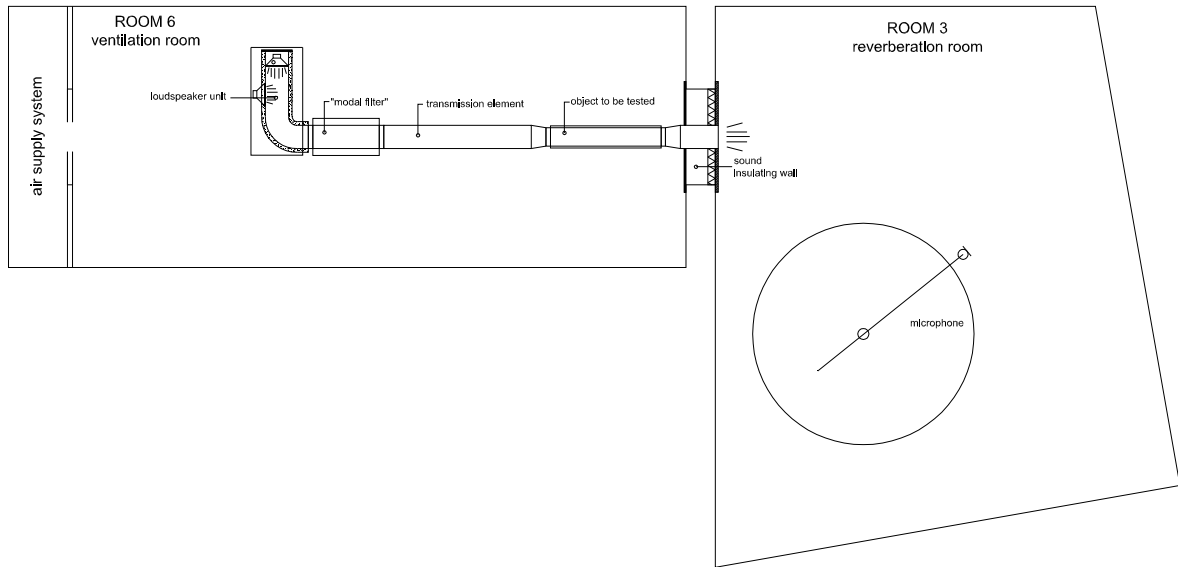
opening (A) (closed)
w x h = 1300 x 1905 mm



TEST OPENINGS (w x h in mm)

- (B) 1000 x 2200
- (C) 1500 x 1250
- (D) 4300 x 2800
- (E) 4000 x 4000



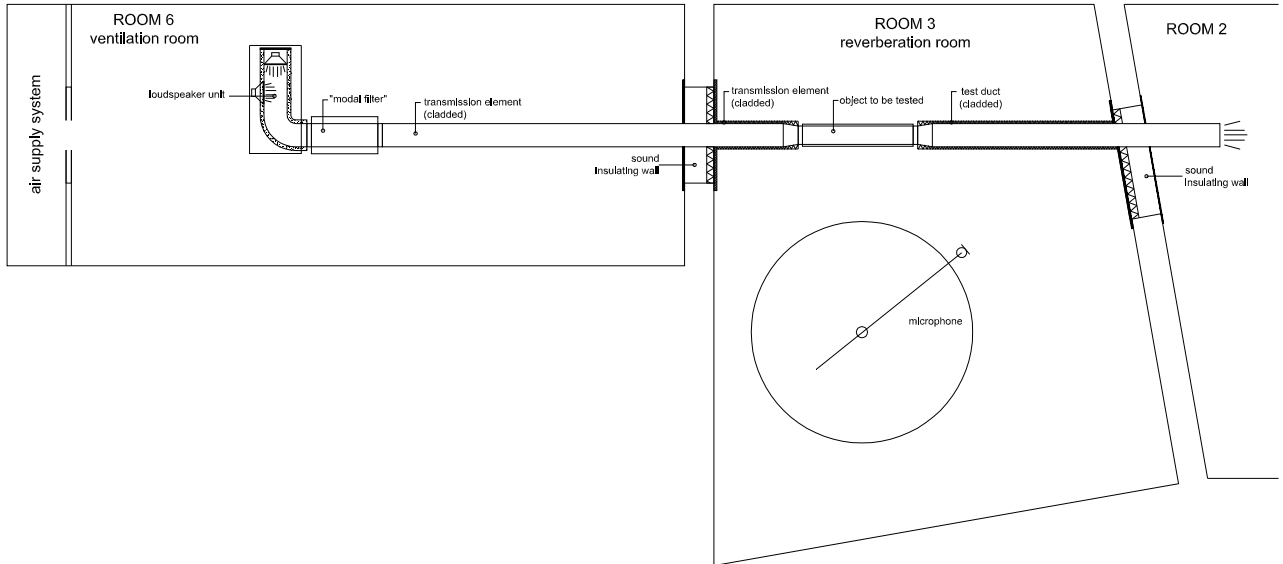


Without silencer; L_{wl}



With silencer; L_{wl}

Measurement set-up insertion loss



Open end; L_{wII}



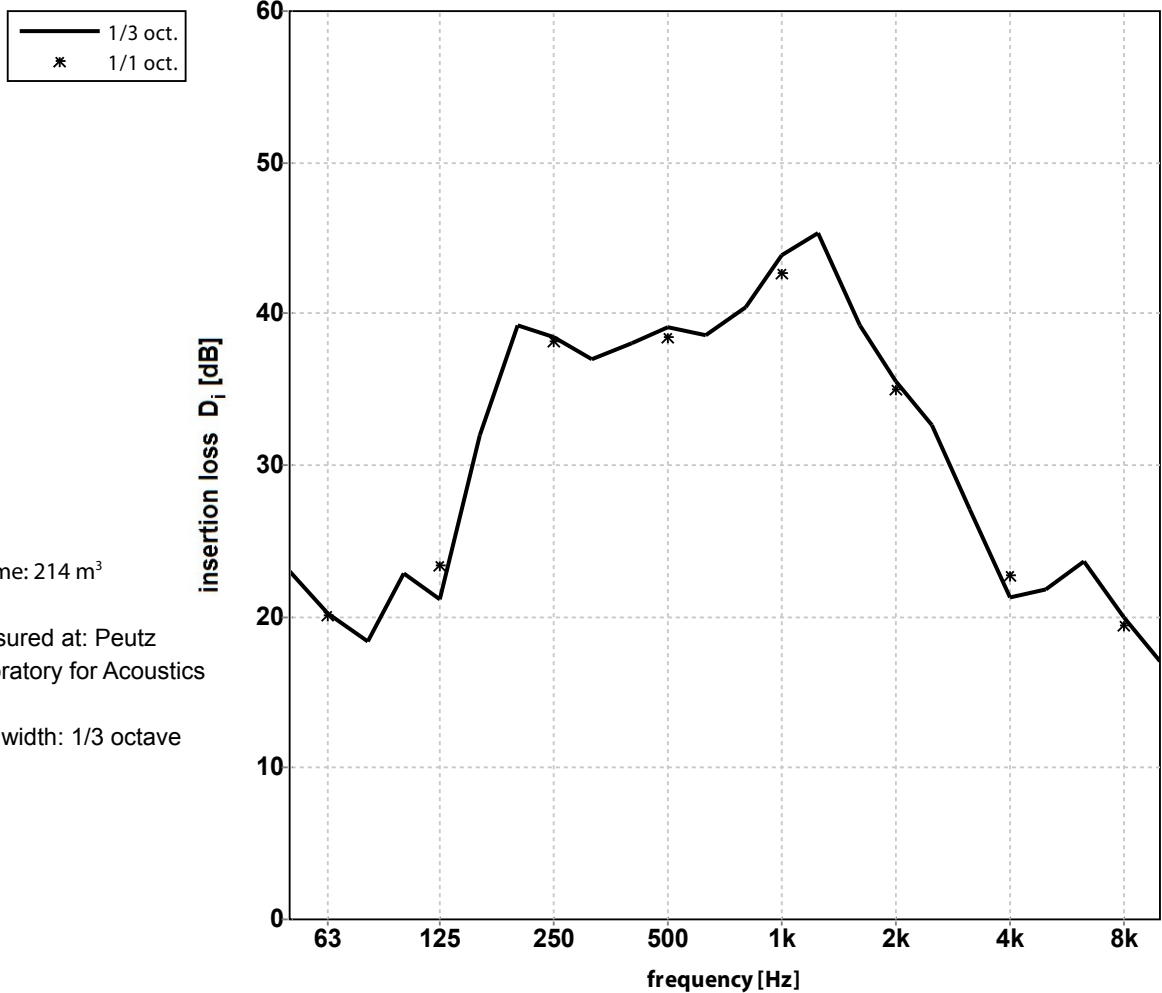
With silencer; L_{wII}

Measurement set-up transmission loss

INSERTION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #27; SILENCERA.FS.P
 diameter 127 mm
 length 1,5 m



volume: 214 m³

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

	63	125	250	500	1k	2k	4k	8k
1/3 oct.	23,0	22,8	39,3	38,0	40,5	39,2	27,1	23,6
	20,2	21,1	38,5	39,1	43,9	35,6	21,3	19,9
	18,4	32,0	37,0	38,6	45,3	32,6	21,8	17,0
1/1 oct.	20,1	23,4	38,2	38,5	42,7	35,0	22,7	19,4

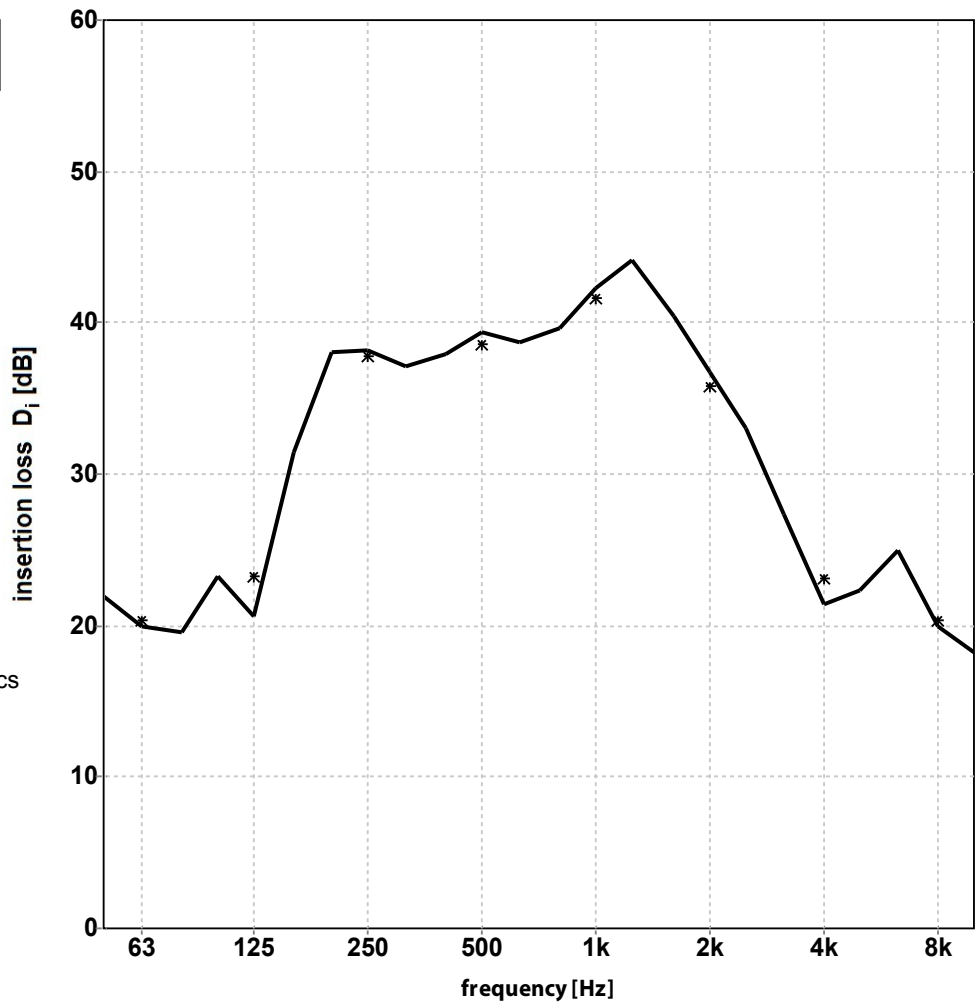
SoundPower 3.8.6b mode 9, PM: TS, file: a2692 Lwl #:258 Lwl #:234 D#:337

INSERTION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #28; SILENCERA.FS.P
 diameter 127 mm
 length 1,5 m

— 1/3 oct.
 * 1/1 oct.



volume: 214 m³

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

	63	125	250	500	1k	2k	4k	8k
1/3 oct.	21,9	23,2	38,1	37,9	39,6	40,5	27,4	25,0
	19,9	20,6	38,2	39,4	42,3	36,8	21,4	19,9
	19,5	31,5	37,1	38,7	44,2	33,1	22,4	18,3
1/1 oct.	20,3	23,2	37,8	38,6	41,6	35,8	23,1	20,3

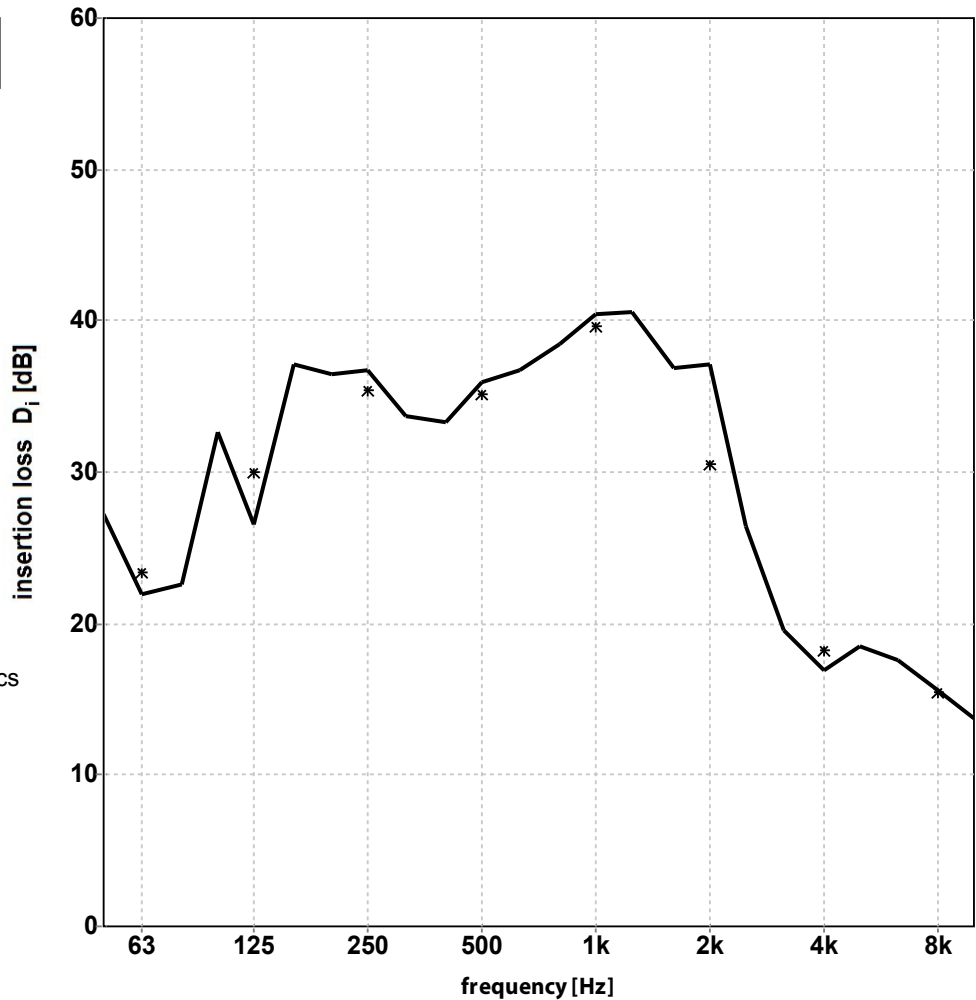
SoundPower 3.8.6b mode 9, PM: TS, file: a2692 Lwl #:260 Lwl #:234 D#:338

INSERTION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #29; SILENCERA.FS.P
 diameter 160 mm
 length 1,5 m

— 1/3 oct.
 * 1/1 oct.



volume: 214 m³

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

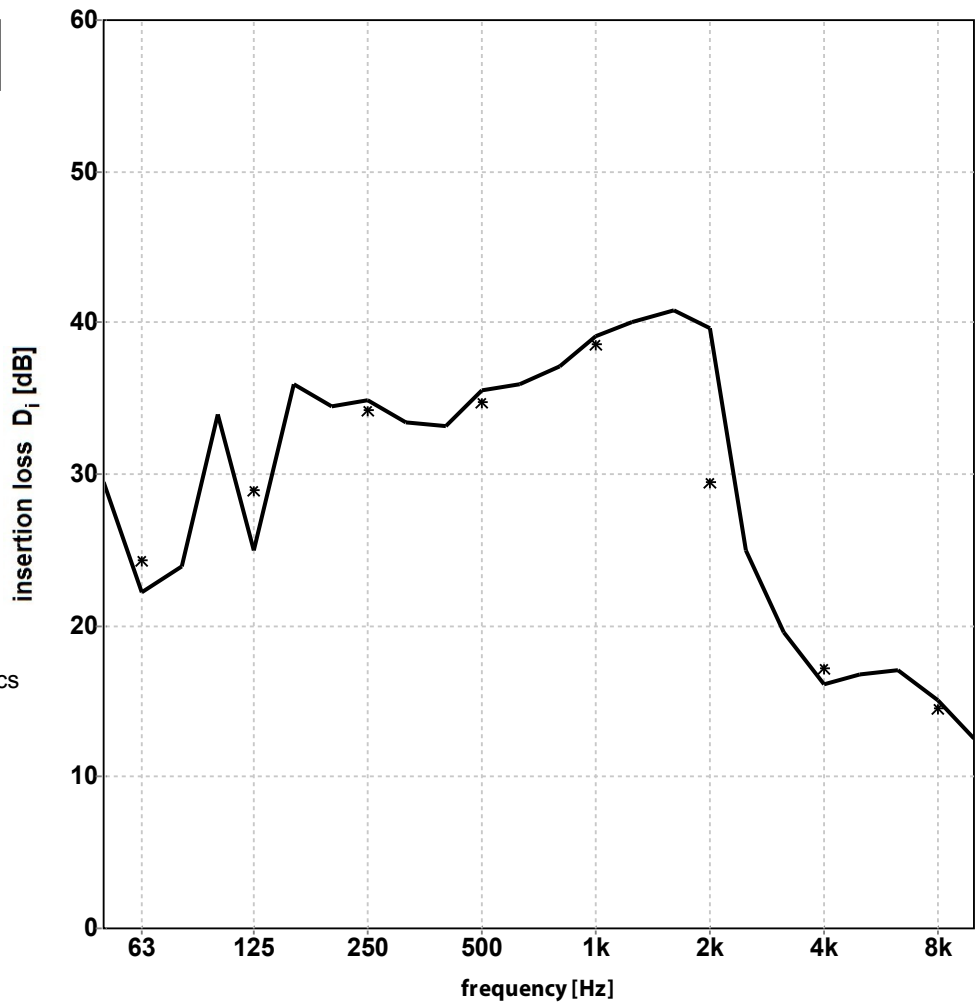
	63	125	250	500	1k	2k	4k	8k
1/3 oct.	27,2	32,7	36,5	33,3	38,4	36,9	19,5	17,6
	22,0	26,5	36,7	36,0	40,4	37,2	16,9	15,6
	22,6	37,2	33,7	36,7	40,6	26,4	18,5	13,8
1/1 oct.	23,4	30,0	35,4	35,1	39,7	30,5	18,2	15,4

INSERTION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #30; SILENCERA.FS.P
 diameter 160 mm
 length 1,5 m

— 1/3 oct.
 * 1/1 oct.



volume: 214 m³

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

	63	125	250	500	1k	2k	4k	8k
1/3 oct.	29,5	34,0	34,5	33,2	37,2	40,8	19,5	17,1
	22,2	25,0	34,9	35,5	39,1	39,6	16,1	15,0
	23,9	35,9	33,4	35,9	40,0	25,0	16,8	12,6
1/1 oct.	24,3	29,0	34,2	34,7	38,6	29,5	17,2	14,5
								dB

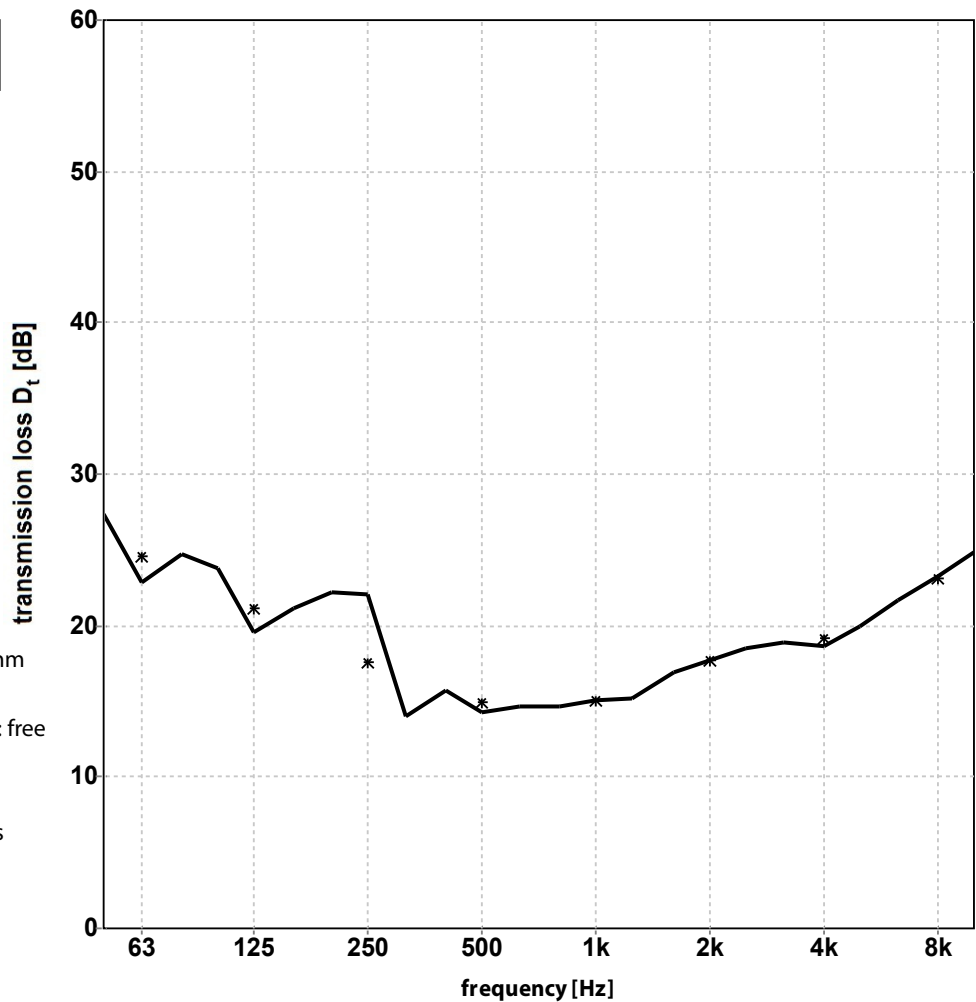
SoundPower 3.8.6b mode 9, PM: TS, file: a2692 Lwl #:320 Lwl #:312 D#:364

TRANSMISSION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: 27; SILENCERAFS.P
 diameter 127 mm
 length 1,5 m

— 1/3 oct.
 * 1/1 oct.



volume: 214 m³

*diameter kanaal: 125 mm

*uitmonding ref. kanaal: free

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

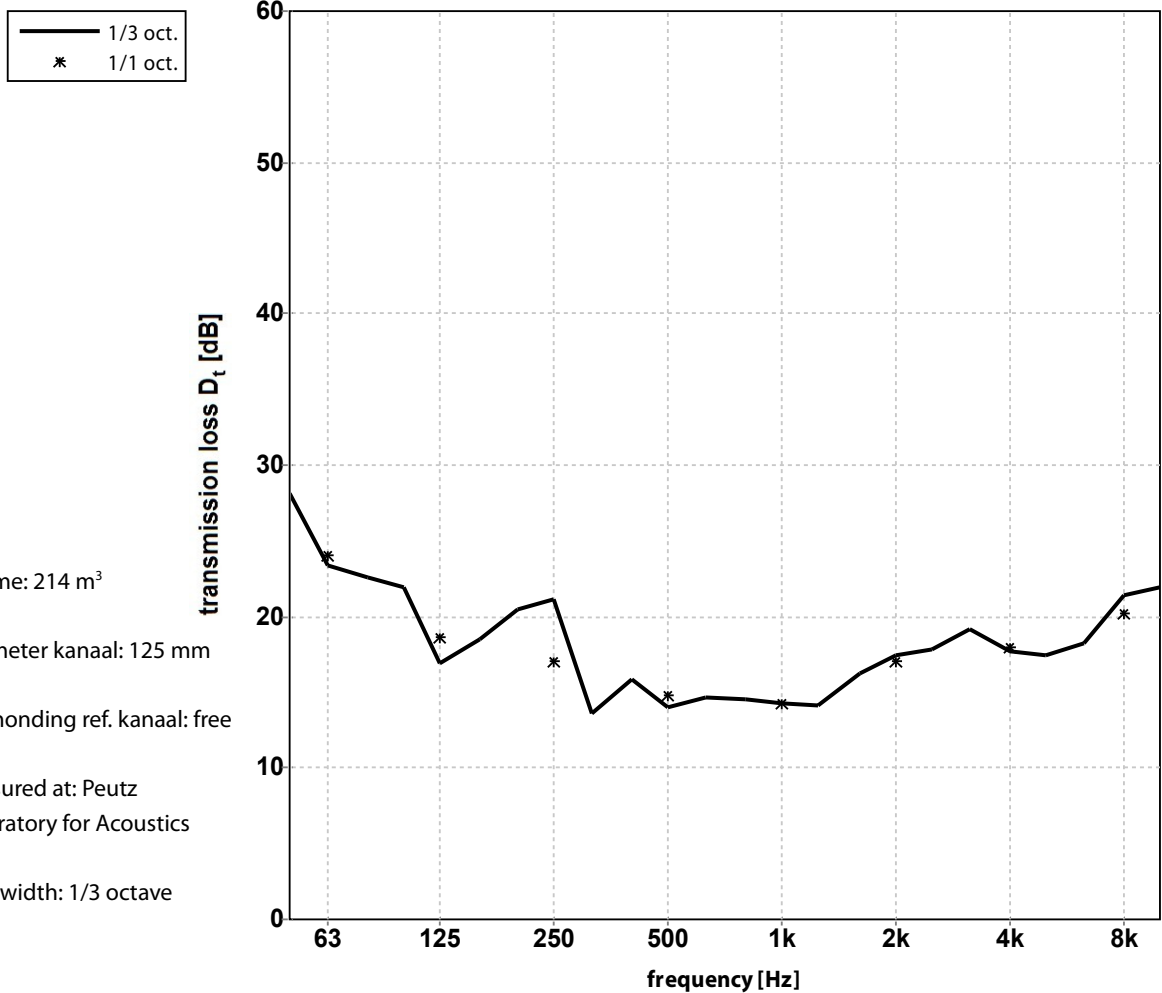
	63	125	250	500	1k	2k	4k	8k
1/3 oct.	27,4	23,8	22,2	15,7	14,7	16,9	18,9	21,7
	22,9	19,5	22,1	14,3	15,0	17,7	18,7	23,3
	24,7	21,1	14,0	14,7	15,2	18,5	20,0	24,8
1/1 oct.	24,6	21,1	17,6	14,9	15,0	17,7	19,2	23,1

SoundPower 3.8.6b mode 10, PM: TS, file: a2692 Lwl #399 Lwl #397 D#495

TRANSMISSION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: 28; SILENCERAFS.P
 diameter 127 mm
 length 1,5 m



volume: 214 m³
 *diameter kanaal: 125 mm
 *uitmonding ref. kanaal: free
 measured at: Peutz
 Laboratory for Acoustics
 bandwidth: 1/3 octave

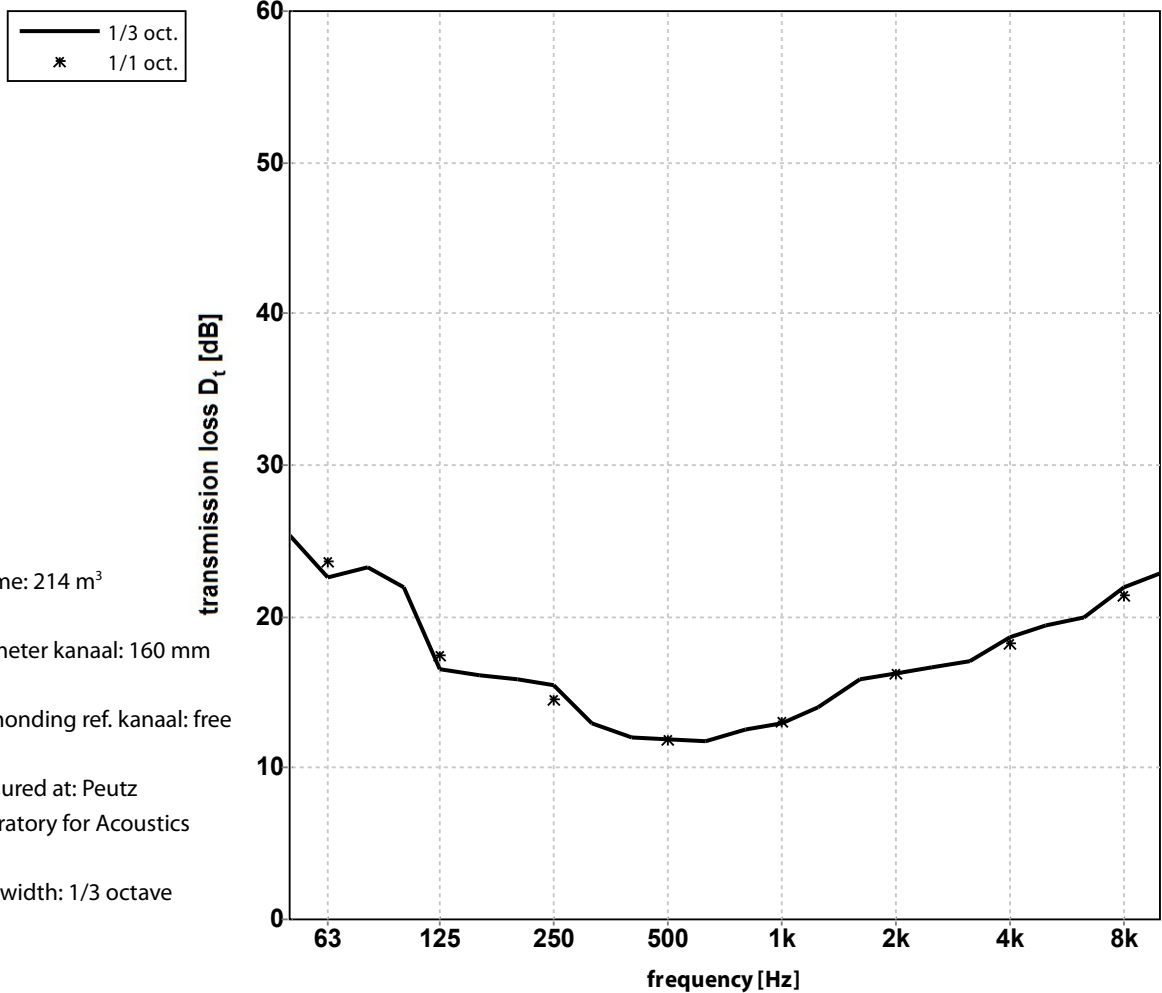
	63	125	250	500	1k	2k	4k	8k	
1/3 oct.	28,2	22,0	20,5	15,8	14,5	16,2	19,1	18,2	
	23,4	16,9	21,1	14,0	14,3	17,4	17,7	21,4	dB
	22,6	18,5	13,6	14,7	14,1	17,9	17,5	22,0	
1/1 oct.	24,1	18,7	17,0	14,8	14,3	17,1	18,0	20,2	dB

SoundPower 3.8.6b mode 10, PM: TS, file: a2692 Lwl #:401 Lwl #:397 D#:496

TRANSMISSION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #29; SILENCERAFS.P
 diameter 160 mm
 length 1,5 m



volume: 214 m³
 *diameter kanaal: 160 mm
 *uitmonding ref. kanaal: free
 measured at: Peutz
 Laboratory for Acoustics
 bandwidth: 1/3 octave

	63	125	250	500	1k	2k	4k	8k	
1/3 oct.	25,4 22,6 23,2	21,9 16,5 16,1	15,8 15,5 13,0	12,0 11,9 11,8	12,6 12,9 14,0	15,8 16,2 16,6	17,0 18,7 19,4	20,0 21,9 22,9	dB
1/1 oct.	23,6	17,5	14,6	11,9	13,1	16,2	18,2	21,4	dB

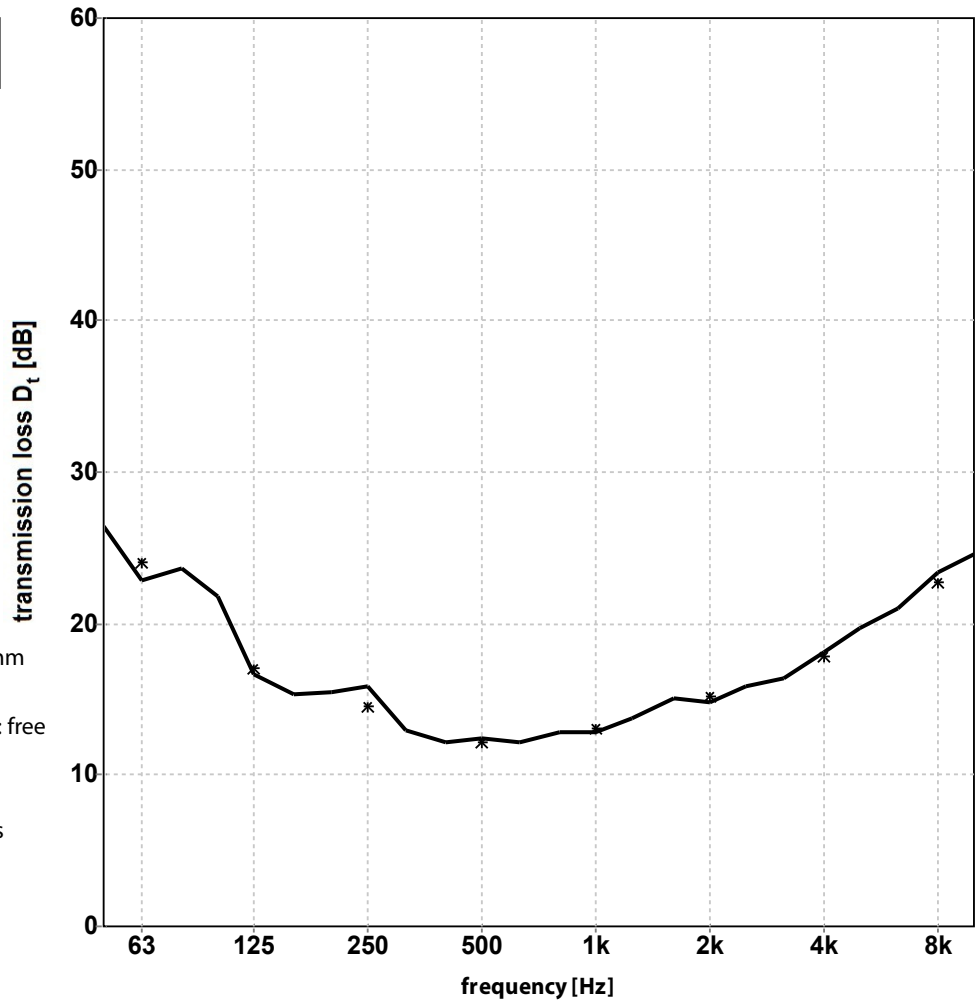
SoundPower 3.8.6b mode 10, PM: TS, file: a2692 Lwl #:465 Lwl #:455 D#:518

TRANSMISSION LOSS ACCORDING TO ISO 7235:2003

principal: AFS Boru Sanayi A.S.

construction tested: #30; SILENCERAFS.P
 diameter 160 mm
 length 1,5 m

— 1/3 oct.
 * 1/1 oct.



volume: 214 m³

*diameter kanaal: 160 mm

*uitmonding ref. kanaal: free

measured at: Peutz
 Laboratory for Acoustics

bandwidth: 1/3 octave

	63	125	250	500	1k	2k	4k	8k	
1/3 oct.	26,4 22,8 23,7	21,8 16,6 15,3	15,4 15,9 12,9	12,1 12,4 12,1	12,8 12,8 13,8	15,1 14,8 15,8	16,4 18,1 19,7	21,0 23,4 24,6	dB
1/1 oct.	24,1	17,1	14,5	12,2	13,1	15,2	17,9	22,7	dB

SoundPower 3.8.6b mode 10, PM: TS, file: a2692 Lwl #:467 Lwl #:455 D#:519