Performance of the ducted silencer FVS3151000

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Assignment	Determination of the performance of the ducted silencer FVS3151000.
Sample details	The customer delivered the silencer, the specifications of which are in appendix 1. Samples were received 14.9.2023 Measurements were carried out 5.10.2023
Methods	Total pressure loss measurements, flow noise measurements and insertion loss measurements were carried out according to ISO 7235:2003 /1/. Description of the test facility is presented in appendix 2. Air flow rates were measured according to ISO 5167-1:2003 and ISO 5167-2:2003 /2/ using orifice plates with corner tappings. FINAS Finnish Accreditation Service has accredited our laboratory (T001) to perform measurements according to standards ISO 7235:2003, ISO 5167-1:2003 and ISO 5167-2:2003. Other measurements mentioned in this test report do not belong to the field of accreditation.

Results

Measurement results are presented in appendix 3.

Measurement results are valid only for the tested samples.

Instruments used in measurements are presented in appendix 4.

References

/1/ ISO 7235:2003. Acoustics - Laboratory measurement procedures for ducted silencers and air-terminal units - Insertion loss, flow noise and total pressure loss.

/2/ ISO 5167-1:2003. Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full. Part 1: General principles and requirements.

ISO 5167-2:2003. Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full. Part 2: Orifice plates.

Espoo, 9.10.2023

Pekka Kettunen
Expert

Mika Hurme
Expert

Appendices 4

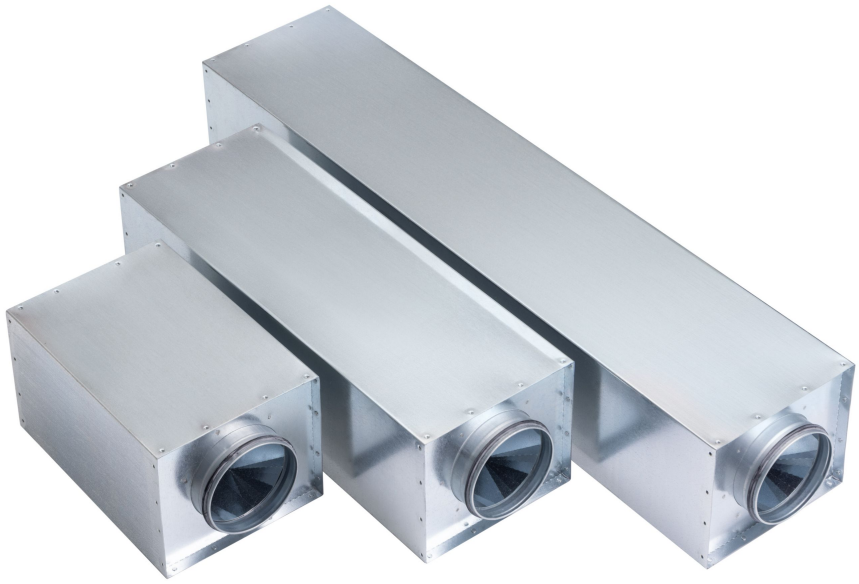
Distribution Customer, electronically approved

Ducted silencer: FVS3151000

Description of the sample

ISO 7235:2003

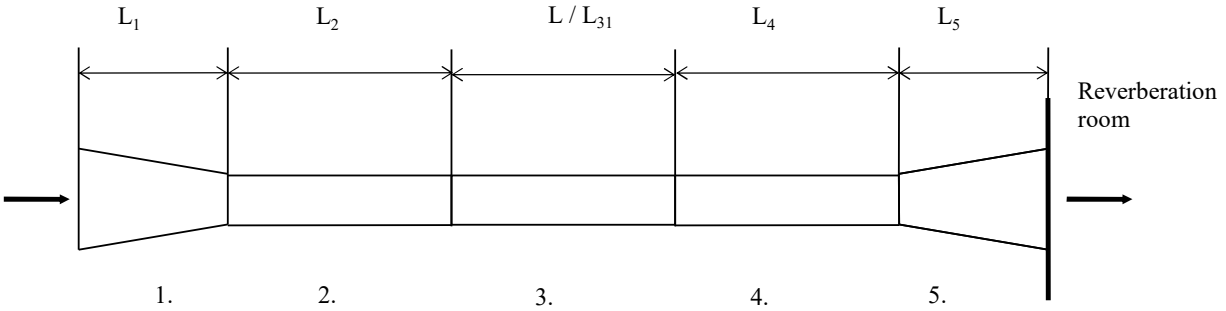
Symbols and units	FVS3151000	Substitution duct
Type	Ducted silencer	Spiral duct
Diameter of the inlet and outlet sections Ød, mm	315	315
Silencer width a, mm	375	-
Silencer height b, mm	435	-
Length L, mm	1000	1000
Mass, kg	14.73	-
Thickness of steel duct material, mm	0.7	0.7
Direction of flow determined	no	no
Direction of insertion loss	no	no



Ducted silencer: FVS3151000

Test facility

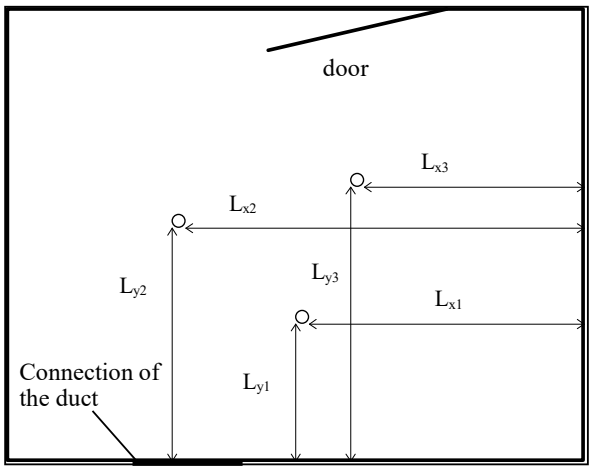
ISO 7235:2003



Components:	Symbols and units	Length
1. Transition Ø1600 / Ø315	L_1, mm	4965
2. Duct Ø315	L_2, mm	2500
3. Transition	L_{31}, mm	-
3. Silencer	L, mm	1000
3. Transition	L_{31}, mm	-
4. Duct Ø315	L_4, mm	3000
5. Transition Ø315 / Ø1250	L_5, mm	3645
Total lenght of the measurement duct, mm		15110

Volume of the reverberation room is 298 m³.

Microphone location in the reverberation room



Symbol	Unit	Distance
L_{x1}	m	2.0
L_{y1}	m	3.6
h_1	m	2.7
L_{x2}	m	3.7
L_{y2}	m	2.1
h_2	m	2.6
L_{x3}	m	4.0
L_{y3}	m	4.1
h_3	m	3.9

Symbols and units

L_x Distance from wall, m

L_y Distance from wall, m

h Distance from floor, m

Ducted silencer: FVS3151000

Test facility

ISO 7235:2003

Volume of the reverberation room: 298 m³

Reverberation time T of the reverberation room and the transmission coefficient τ of the measurement duct transmission element Ø 315 mm.

Symbol	Unit	T
T_{50}	s	3.69
T_{63}	s	3.38
T_{80}	s	4.48
T_{100}	s	4.05
T_{125}	s	5.21
T_{160}	s	4.49
T_{200}	s	4.94
T_{250}	s	5.39
T_{315}	s	4.93
T_{400}	s	4.18
T_{500}	s	4.21
T_{630}	s	4.47
T_{800}	s	4.61
T_{1000}	s	4.73
T_{1250}	s	4.24
T_{1600}	s	4.02
T_{2000}	s	3.76
T_{2500}	s	3.38
T_{3150}	s	2.93
T_{4000}	s	2.50
T_{5000}	s	2.33
T_{6300}	s	1.91
T_{8000}	s	1.40
T_{10000}	s	1.11

Symbol	Unit	τ
τ_{50}	-	0.773
τ_{63}	-	0.987
τ_{80}	-	0.949
τ_{100}	-	0.971
τ_{125}	-	0.987
τ_{160}	-	0.987
τ_{200}	-	0.997
τ_{250}	-	0.997
τ_{315}	-	0.997
τ_{400}	-	0.997
τ_{500}	-	0.997
τ_{630}	-	0.997
τ_{800}	-	1.000
τ_{1000}	-	1.000
τ_{1250}	-	1.000
τ_{1600}	-	1.000
τ_{2000}	-	1.000
τ_{2500}	-	1.000
τ_{3150}	-	1.000
τ_{4000}	-	1.000
τ_{5000}	-	1.000
τ_{6300}	-	1.000
τ_{8000}	-	1.000
τ_{10000}	-	1.000

Transmission coefficient τ has not been measured at frequencies below 50 Hz.

Symbols and units

$T_{50\ldots10000}$ Reverberation time, s

$\tau_{50\ldots10000}$ Transmission coefficient, -

$_{50\ldots10000}$ Centre frequency of one-third octave band, Hz

Ducted silencer: FVS3151000

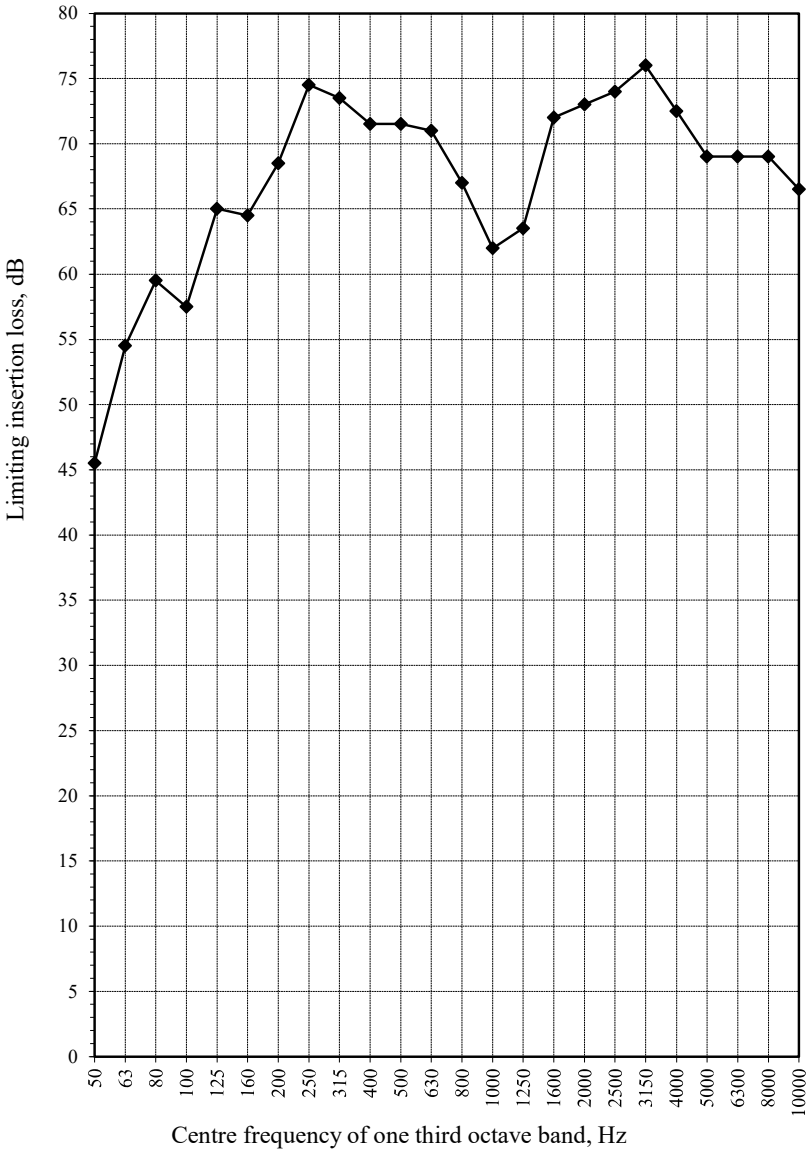
Limiting insertion loss of the test facility

ISO 7235:2003

Diameter of the inlet and outlet sections: 315 mm

Length of the measurement duct: 15110 mm

Symbol	Unit	D
$D_{1/3oct50}$	dB	45.5
$D_{1/3oct63}$	dB	54.5
$D_{1/3oct80}$	dB	59.5
$D_{1/3oct100}$	dB	57.5
$D_{1/3oct125}$	dB	65.0
$D_{1/3oct160}$	dB	64.5
$D_{1/3oct200}$	dB	68.5
$D_{1/3oct250}$	dB	74.5
$D_{1/3oct315}$	dB	73.5
$D_{1/3oct400}$	dB	71.5
$D_{1/3oct500}$	dB	71.5
$D_{1/3oct630}$	dB	71.0
$D_{1/3oct800}$	dB	67.0
$D_{1/3oct1000}$	dB	62.0
$D_{1/3oct1250}$	dB	63.5
$D_{1/3oct1600}$	dB	72.0
$D_{1/3oct2000}$	dB	73.0
$D_{1/30ct2500}$	dB	74.0
$D_{1/3oct3150}$	dB	76.0
$D_{1/3oct4000}$	dB	72.5
$D_{1/3oct5000}$	dB	69.0
$D_{1/3oct6300}$	dB	69.0
$D_{1/3oct8000}$	dB	69.0
$D_{1/3oct10000}$	dB	66.5



Symbols and units

$D_{1/3oct50...10000}$ Limiting insertion loss in one-third octave bands, dB

$_{50...10000}$ Centre frequency of one third octave band, Hz

Ducted silencer: FVS3151000

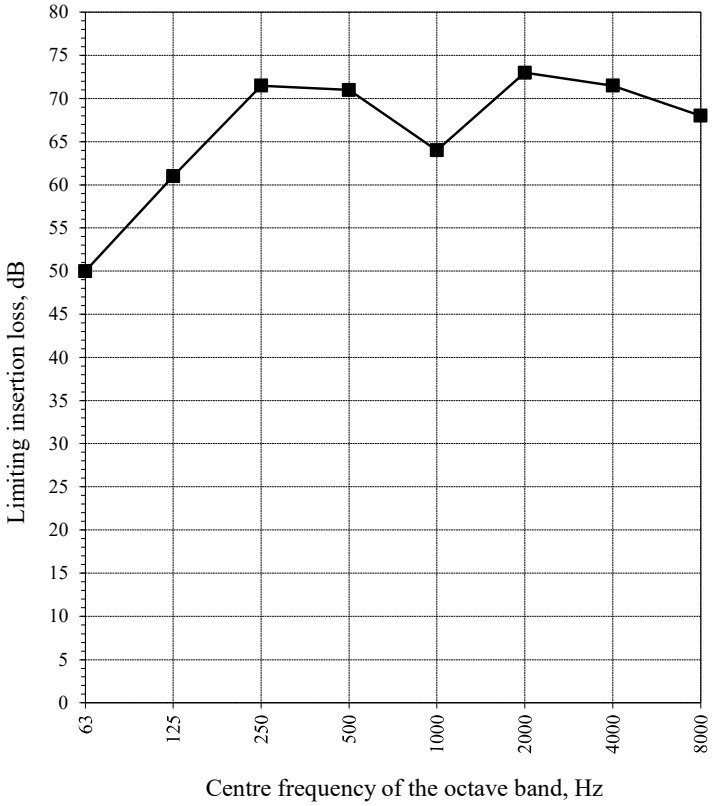
Limiting insertion loss of the test facility

ISO 7235:2003

Diameter of the inlet and outlet sections: 315 mm

Length of the measurement duct: 15110 mm

Symbol	Unit	D
D_{oct63}	dB	50.0
D_{oct125}	dB	61.0
D_{oct250}	dB	71.5
D_{oct500}	dB	71.0
$D_{oct1000}$	dB	64.0
$D_{oct2000}$	dB	73.0
$D_{oct4000}$	dB	71.5
$D_{oct8000}$	dB	68.0



Symbols and units

$D_{oct63...8000}$ Limiting insertion loss in octave bands, dB

$_{63...8000}$ Centre frequency of octave band, Hz

Ducted silencer: FVS3151000

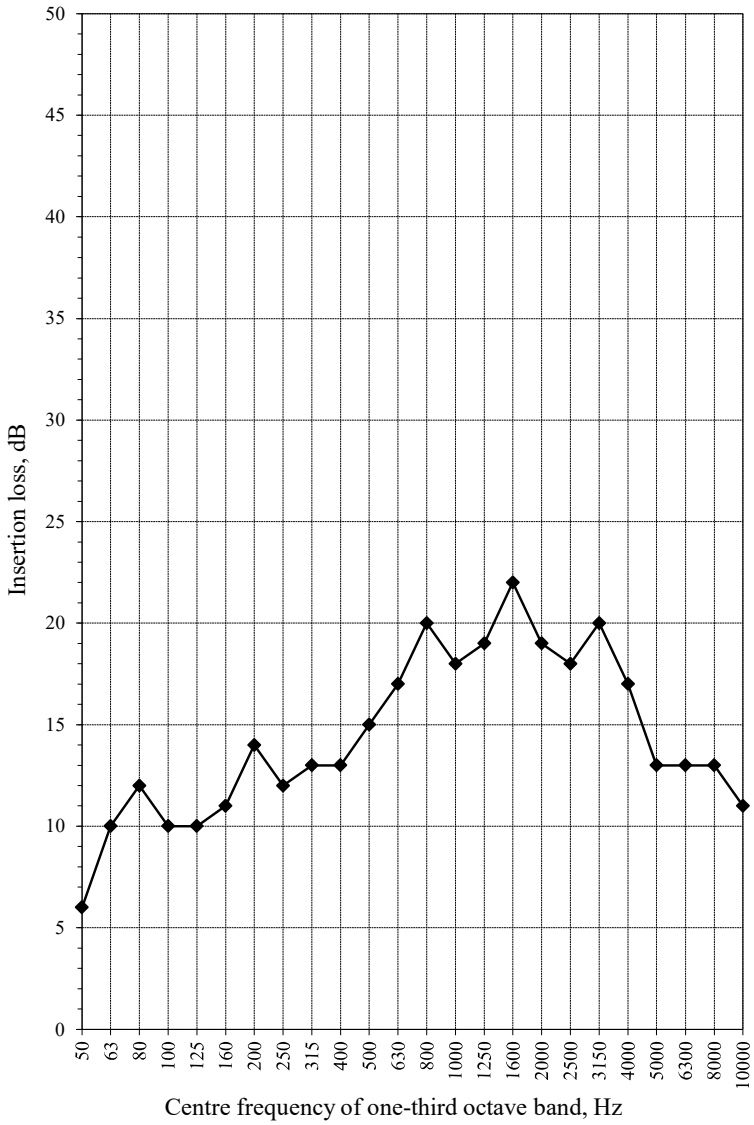
Insertion loss in one-third octave bands

ISO 7235:2003

Size of the inlet and outlet sections: ø 315 mm

Length: 1000 mm

Symbol	Unit	D_i
$D_{1/3oct50}$	dB	6
$D_{1/3oct63}$	dB	10
$D_{1/3oct80}$	dB	12
$D_{1/3oct100}$	dB	10
$D_{1/3oct125}$	dB	10
$D_{1/3oct160}$	dB	11
$D_{1/3oct200}$	dB	14
$D_{1/3oct250}$	dB	12
$D_{1/3oct315}$	dB	13
$D_{1/3oct400}$	dB	13
$D_{1/3oct500}$	dB	15
$D_{1/3oct630}$	dB	17
$D_{1/3oct800}$	dB	20
$D_{1/3oct1000}$	dB	18
$D_{1/3oct1250}$	dB	19
$D_{1/3oct1600}$	dB	22
$D_{1/3oct2000}$	dB	19
$D_{1/30ct2500}$	dB	18
$D_{1/3oct3150}$	dB	20
$D_{1/3oct4000}$	dB	17
$D_{1/3oct5000}$	dB	13
$D_{1/3oct6300}$	dB	13
$D_{1/3oct8000}$	dB	13
$D_{1/3oct10000}$	dB	11



Symbols and units

D_i	Insertion loss, dB
$D_{1/3oct50...10000}$	Insertion loss in one-third octave bands, dB
$_{50...10000}$	Centre frequency of one third octave band, Hz

Ducted silencer: FVS3151000

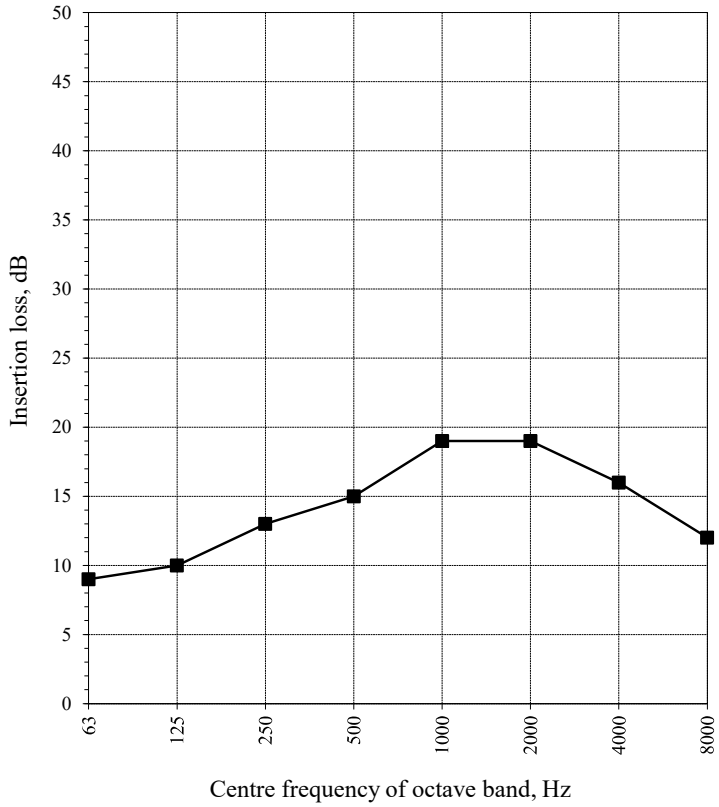
Insertion loss in octave bands

ISO 7235:2003

Size of the inlet and outlet sections: ø 315 mm

Length: 1000 mm

Symbol	Unit	D_i
D_{oct63}	dB	9
D_{oct125}	dB	10
D_{oct250}	dB	13
D_{oct500}	dB	15
$D_{oct1000}$	dB	19
$D_{oct2000}$	dB	19
$D_{oct4000}$	dB	16
$D_{oct8000}$	dB	12



Symbols and units

D_i	Insertion loss, dB
$D_{oct63...8000}$	Insertion loss in octave bands, dB
$_{63...8000}$	Centre frequency of octave band, Hz

Ducted silencer: FVS3151000

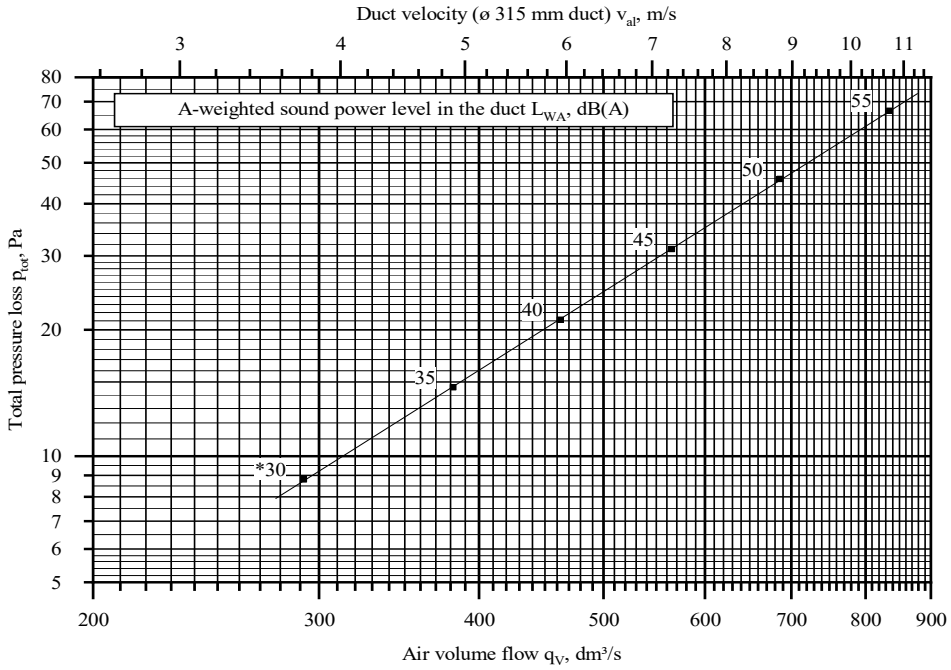
Pressure loss and flow noise in octave bands

ISO 7235:2003

Air density 1,20 kg/m³

Size of the inlet and outlet sections: ø 315 mm

Length: 1000 mm



Symbol	Unit	1	2	3	4	5	6
q_V	m³/s	292	382	463	565	687	835
v_{a1}	m/s	3.75	4.90	5.94	7.25	8.81	10.7
p_{tot}	Pa	8.8	14.6	21.1	31.1	45.7	66.5
ζ_{tot}	-	1.04	1.01	1.00	0.99	0.98	0.96
L_{W63}	dB	*38.8	42.6	46.2	50.7	54.7	59.9
L_{W125}	dB	37.4	40.3	43.6	47.1	51.2	55.5
L_{W250}	dB	*33.3	36.9	40.3	43.9	47.9	51.9
L_{W500}	dB	*27.4	33.5	37.7	41.8	45.5	49.2
L_{W1000}	dB	*20.8	29.6	35.7	41.4	46.2	50.5
L_{W2000}	dB	*14.6	*21.6	29.7	36.3	43.4	48.3
L_{W4000}	dB	*17.4	*18.1	*21.4	*28.7	36.5	43.2
L_{W8000}	dB	*23.8	*23.8	*23.9	*24.8	*29.4	37.5
L_W	dB	*42.1	45.7	49.3	53.5	57.8	62.5
L_{WA}	dB(A)	*30.2	35.2	40.0	45.1	50.2	54.8

*) The background noise requirements of standard ISO 3741:2010 have not been met.

Data represent upper bounds to the sound power level of the noise source under test.

Symbols and units

q_V	Air volume flow rate, m³/s	$L_{W63...8000}$	Sound power level in the duct in octave bands, dB
v_{a1}	Duct velocity (ø315 mm duct), m/s	$_{63...8000}$	Centre frequencies of the octave bands, Hz
p_{tot}	Total pressure loss, Pa	L_W	Sound power level in the duct, dB
ζ_{tot}	Total pressure loss coefficient, -	L_{WA}	A-weighted sound power level in the duct, dB(A)

Instruments used:

Instrument	Type code	Serial number	Calibrated
Micromanometer	Furness FC012	9802124	07/2023
Micromanometer	Furness FC012	110057	07/2023
Micromanometer	Furness FC012	9802125	07/2023
Barometer	Vaisala PTB220BAC2A1	W4230002	07/2023
Hygrometer	Rotronic HTT	8501156	12/2022
Temperature logger	Agilent 34970A	MY44071581	07/2023
Pistonphone	B&K 4228	3063558	10/2022
Microphone	B&K 4943	2415046	before measurements
Microphone preamplifier	B&K 2660	15040598	
Real-time analyser	Norsonic RT 830-2	11504	07/2020, chk. 12/2022
Rotating microphone stand	B&K 3923	1678218	
Reverberation room	298 m³		