Heating boilers — Test regulations for airborne noise emissions from heat generators —

Part 2: Flue gas noise emissions at the outlet of the heat generator

The European Standard EN 15036-2:2006 has the status of a British Standard

ICS 17.140.20; 91.140.10

British Standards

National foreword

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This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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Chaudières de chauffage - Règles d´essais des émissions de bruit aérien des générateurs de chaleur - Partie 2: Émissions de bruit de cheminée à la sortie du générateur

Heizkessel - Prüfverfahren für Luftschallemissionen von Wärmeerzeugern - Teil 2: Abgasgeräuschemissionen am Ausgang des Wärmeerzeugers

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Foreword

This document (EN 15036-2:2006) has been prepared by Technical Committee CEN/TC 57 “Central heating boilers”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by March 2007, and conflicting national standards shall be withdrawn at the latest by March 2007.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland and United Kingdom.

Introduction

Establishing the A-weighted sound pressure level and its spectral distribution in the flue gas path of a heat generator is significant for estimating the noise emission expected in the vicinity and for the rating of flue gas silencers. This European Standard describes a procedure for measuring sound pressure levels in the flue gas path of heat generators derived from EN ISO 5136:2003.

The sound power radiated from a heat generator through its flue gas path depends to some extent on the design of the flue gas system (changes in direction and cross-section, installations, and natural frequencies) as described by the acoustic impedance. Any measurement procedure therefore requires the measurement duct to be specified unambiguously if comparable readings are to be obtained. In the procedure described here, the measurement duct has a circular cross-section and is fitted with a low-reflection end-piece as described in annex A. The sound power measured under these conditions can be regarded as representative for all practical applications.

The level of measurement uncertainty is described by the standard deviation that is to be expected if the same readings are taken in different laboratories.

1 Scope

This European Standard applies to heat generators according to EN 15036-1, which are connected to chimneys/ducts which discharge combustion products via a duct into open air.

The data measured according to this European Standard will probably be different from the noise radiated from the end of the chimney.

Readings from forced-draught burners complying with EN 267 or EN 676 are only applicable in practice if they have been taken in conjunction with a boiler. Noise emitted into chimneys/ducts by heat generators operating independently of indoor air can also be measured in accordance with this European Standard.

Boilers supplied with combined air inlet and exhaust terminal configuration where ducts are within an external wall can be measured according to one of the test methods detailed in EN 15036-1.

This European Standard describes the objective procedure for determining sound power levels $L_{W,}$ at the outlet of a heat generator that is emitting broad-band, narrow-band, or tonal continuous sound.

This European Standard is applicable to boilers designed to be connected to a chimney or flue duct with a duct size greater than or equal to 0,06 m and whose mean flue gas flow at the microphone head is less than 5 m/s.

This European Standard only applies for test purposes under laboratory conditions.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 437, *Test gases — Test pressures — Appliance categories*

EN 15036-1, *Heating boilers — Test regulations for airborne noise emissions from heat generators — Part 1: Airborne noise emissions from heat generators*

CEN/TR 1749, *European scheme for the classification of gas appliances according to the method of evacuation of the combustion products (types)*

EN 60942, *Electroacoustics — Sound calibrators (IEC 60942:2003)*

EN 61260, *Electroacoustics — Octave band and fractional-octave-band filters (IEC 61260:1995)*

EN 61672-1, *Electroacoustics — Sound level meters — Part 1: Specifications (IEC 61672-1:2002*

EN ISO 266, *Acoustics — Preferred frequencies (ISO 266 1997)*

3 Terms and definitions

For the purposes of this European Standard, the following terms and definitions apply.

3.1 duct

3.1.1
test duct
duct in which a heat generator's sound power is measured

NOTE The test duct has an anechoic termination.

3.1.2
intermediate duct
duct fitted to the intake side and to the discharge side of the heat generator to ensure desired flow conditions

NOTE The intermediate duct connects to the test duct, if necessary by a transition section.

3.2
sound pressure level
L_p

$$L_p = 10 \lg \frac{p^2}{p_0^2} dB$$

where

p is the mean square root value of the sound pressure and the reference sound pressure p_0 is equal to 20 μ Pa

NOTE 1 The width of a restricted frequency band should be indicated, for example, octave-band sound pressure level, one-third-octave-band sound pressure level.

NOTE 2 L_{p1}, L_{p2} and L_{p3} are sound pressure levels at each of the three measurement positions in the test duct. Sound pressure levels may also be obtained from a continuous circumferential traverse (see 5.2).

$\overline{L}_{pm}$ is the spatially averaged sound pressure level obtained from averaging over three measurements positions in the test duct. It may also be obtained from a continuous circumferential traverse (see 5.2).

$\overline{L}_p$ is the spatially averaged sound pressure level at the measurement plane, corrected for the combined free-field response *C* (see Table 1 and 8.1)

NOTE 3 The sound pressure level is expressed in decibels (dB).

[EN ISO 5136:2003, definition 3.5]

3.3
sound power level
L_W

$$L_W = 10 \lg \frac{P}{P_0} dB$$

where

P is the sound power and the reference sound power P_0 is equal to 1 pW

NOTE 1 The width of a restricted frequency band should be indicated, for example, octave-band sound power level, one-third-octave-band sound power level.

NOTE 2 The sound power level is expressed in decibels (dB).

[EN ISO 5136:2003, definition 3.6]

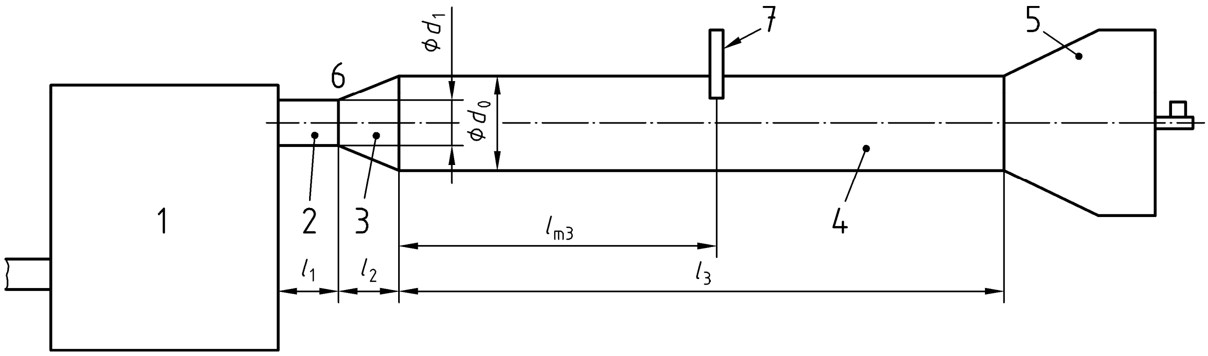
4 Set-up and measurement equipment

4.1 General

For the tests the boiler shall be installed and fired with fuels in accordance with the appliance manufacturer's instructions. For a gas boiler the test gas shall be in accordance with the appliance category and EN 437. The fuel used for the test shall be stated in the test report.

According to CEN/TR 1749, the test arrangement for type B and type C boilers with non-concentric ducts, shall consist of the boiler under test, an intermediate duct, the test duct with anechoic termination and the instrumentation (see Figure 1 and Figure 2).

According to CEN/TR 1749, the test arrangement for type C boilers with concentric ducts (C1 and C3), shall consist of the boiler under test to which is applied the pressure drop corresponding to the maximum length of flue declared by the manufacturer, its test duct with anechoic termination and the instrumentation. For type C boilers which can only be installed with short flue ducts e. g. 300 mm which are supplied with the boiler by the appliance manufacturer shall be measured using one of the test methods according to EN 15036-1.



Key

1 boiler

2 intermediate duct (if required)

3 transitions duct (if required)

4 test duct (Measurement level)

5 anechoic termination (see annex A, for details)

6 pressure outlet point

7 microphone

d_0 diameter of test duct, in m (at least 0,06 m)

d_1 diameter of flue gas outlet from the boiler, in m

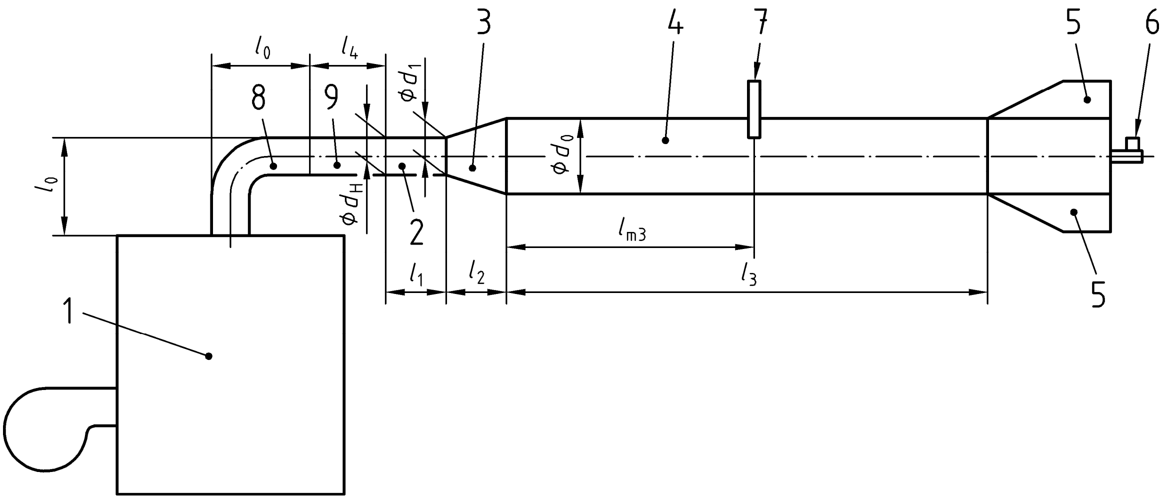
l_1 length of intermediate duct, in m

l_2 length of transitions, in m

l_3 length of test duct, in m

l_{m3} distance of the microphone position, in m.

Figure 1 — Test configuration for rear outlet



Key

1	boiler	d_0 diameter of test duct, in m (at least 0,06 m)
2	intermediate duct (if required)	d_1 diameter of intermediate duct, in m
3	transitions duct (if required)	d_H diameter of flue gas outlet from the boiler, in m
4	test duct (measurement level)	l_0 length of bent, in m (max 0,25 m)
5	anechoic termination (see annex A for details)	l_1 length of intermediate duct, in m
6	pressure outlet point	l_2 length of transitions, in m
7	microphone	l_3 length of test duct, in m
8	bent	l_4 length of flue gas outlet, in m (max 1 m)
9	flue gas outlet	l_{m3} distance of the microphone position, in m

Figure 2 — Test configuration for top outlet

All connections between the heat generator and the duct shall be rigid unless a vibration-isolated coupling is an integral component part of the heat generator. A mounting for a microphone shall be provided at the point on the measurement duct identified for this purpose in Figure 1 and Figure 2.

The pressure at the outlet of the boiler should be set at the required level given by the manufacturer; any deviation should be recorded.

If the flue gas outlet of the boiler is vertically mounted, a bend shall be installed directly behind this outlet. The test duct shall be connected to this bend. The ratio of the bend's radius to the diameter of the duct shall be as big as possible, in order to minimise the bend's influence on the transmitted noise.

4.2 Specification of the duct

4.2.1 Design of ducts and transitions

The duct shall be straight, coaxial with the outlet of the heat generator, and of a constant circular cross-section all along its length. The duct and transitions shall be made either of steel or of a material with an equivalent area-mass and rigidity, in order to ensure a smooth, reverberate internal surface so that no vibrations can occur that could affect the readings.

4.2.2 Duct lengths and distances between them

The duct lengths and the distances between them shall be selected in accordance with the specifications shown in Figure 1, Figure 2 and Table 1.

Table 1 — Duct lengths

Duct	**Length** **m**
Intermediate duct	$l_1 = d_1$
Length of transitions	l_2 = see 4.2.3
Test duct	$l_3 \geq 4 \times d_0$ or ≥ 1 m (whichever is the greater)
Distance of the microphone position	$l_{m3} = 0{,}5 \times l_3$

NOTE To achieve greater accuracy at lower frequencies (i.e. below 50 Hz) the length of test duct l_3 should be increased to 4 m or 6 x d_0 diameter of the test duct.

The duct cross-sectional areas are shown in Table 2 where "*S*" represents the cross-sectional area in m^2 of the flue gas outlet at the heat generator.

Table 2 — Duct cross-sectional areas

Duct	**Cross-sectional area**	
	Minimum	**Maximum**
Intermediate duct	0,95 × *S*	1,07 × *S*
Test duct	0,7 × *S*	2,1 × *S*

4.2.3 Transition ducts

The test or terminating duct shall be coupled directly to the intermediate duct, or where there is a change of cross-sectional area, indirectly by means of a transition duct. The diameter ratio of the transition shall lie within the limits specified in Table 2.

For acoustic reasons the length of the transition shall be such that the minimum length of transition l_{2min} conforms to equation (1):

$$l_{2min} \geq l_0 \left(\frac{S_l}{S_s} - 1 \right) \tag{1}$$

where:

l_0 1 m;

S_l larger area;

S_s smaller area.

For aerodynamic reasons the outlet transition shall have an opening angle not exceeding 15° and in many cases, this will be the factor that will determine the length.

4.2.4 Anechoic termination

The pressure reflection coefficient r_a, of the anechoic termination measured at ambient temperature shall not exceed the values shown in Table 3.

The pressure reflection coefficient *ra,* can be calculated according to Annex B.

Table 3 — Maximum permissible values of the pressure reflection coefficient of the anechoic termination

One-Third-octave-band centre frequency Hz	Maximum pressure reflection coefficient in the test duct
50	0,4
63	0,35
80	0,3
100	0,25
≥125	0,15
NOTE If there is an open duct end with a diameter of 1,6 m or more, the requirements for the maximum pressure reflection coefficient are satisfied.	

Guidelines for the design of the anechoic terminations and a method for measuring the pressure reflection coefficient of the termination are given in Annexes A and B.

4.3 Instrumentation

4.3.1 Measuring equipment

4.3.1.1 Microphone

A microphone should be used for the sound level measurement that meets the requirements of Class 1 as defined in EN 61672-1.The microphone and its cable shall be designed in such a way that the sensitivity does not change over the temperature range encountered during the measurement cycle. In many cases a high temperature resistant microphone is necessary.

4.3.1.2 Frequency analyser

A third-band filter should be used that complies with EN 61260. The band centre frequency shall comply with EN ISO 266.

4.4 System calibration

The whole measuring system shall be checked at the microphone before and after each measurement cycle with a sound calibrator that meets the requirements of Class 1 as defined in EN 60942.

5 Test arrangements

5.1 Mounting the microphone

The microphone shall be mounted in the test duct at the distance l_{m3} as shown in Figure 1 and Figure 2.

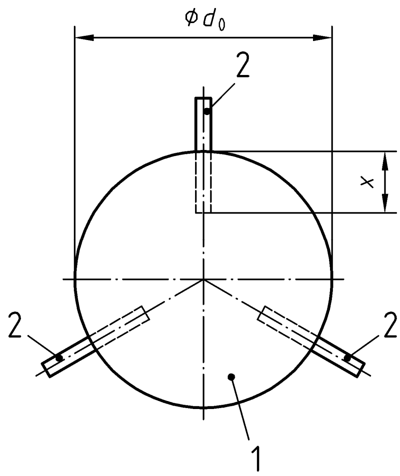
NOTE The microphone should be insulated against vibration from the measurement duct walls so that structure-borne noise cannot be transmitted to the microphone.

5.2 Radial microphone position

The microphone shall be mounted at three radial positions at an angle of 120° as shown in Figure 3 and Table 4.

Table 4 — Position of the microphone in the measurement duct

Measurement duct diameter d_0 **m**	**Immersion depth *x* of the microphone into the measurement duct**
$0{,}06 \leq d_0 \leq 0{,}13$	$0{,}25\ d_0$
$d_0 > 0{,}13$	$0{,}1\ d_0$
NOTE The positions stated here ensure that a good approximate value for the sound power can be obtained from measurement of sound pressure.	



Key

1 test duct

2 microphone

d_0 diameter of test duct, in m

x immersion depth of the microphone, in m

Figure 3 — Position of the microphone

6 Test procedure

6.1 Operating conditions

The test shall be carried out as soon as the operating conditions have stabilised and shall be carried out at the operating point with the highest level of noise emission in stable operating condition. This is usually the point of nominal output as stated by the manufacturer.

The load and operating conditions of the heat generator shall comply with the manufacturer’s instructions.

The start-up and switch-off behaviour of the appliance and its operation for heating domestic hot water shall not be taken into account.

6.2 Measuring the sound pressure level readings

6.2.1 General

The sound pressure level is measured as a global A-weighted level and in the third-octave bands normally in the frequency range from 50 Hz to 5 000 Hz, however higher or lower frequencies may need to be measured, if emissions in those frequencies bands are found to be high. Background noise shall be at least 10 dB lower than the noise to be measured in each frequency band of interest.

6.2.2 Sampling time

The sound pressure level averaged over time shall be identified at the measurement positions described in 5.1. For third-octave bands with centre frequencies equal to or less than 160 Hz the duration of measurement shall be at least 30 s, and for those equal to or greater than 200 Hz, at least 10 s. Longer measurement periods may be necessary if the sound pressure to be measured varies over time. These average sound pressure levels should be approximated to the nearest tenth of a decibel.

7 Calculations

7.1 Average sound pressure level

The average sound pressure level $\overline{L_\mathrm{p}}$, in decibels, shall be calculated for each frequency band in accordance with equation (2):

$$\overline{L_\mathrm{p}} = 10 \cdot \lg\left[\frac{1}{n}\sum_{i=1}^{i=n} 10^{0,1 L_\mathrm{pi}}\right] \text{ in dB} \qquad (2)$$

where:

n the number of measurement positions, generally = 3;

L_pi the time-averaged sound pressure level ,in decibels, at the i^th measurement position.

7.2 Sound power level

The sound power level L_W,in decibels, of the sound radiating into the test duct for each frequency band shall be calculated by using the plane- wave equation (3):

$$L_W = \overline{L_p} + \left(10 \cdot \lg \frac{S}{S_0} - 10 \cdot \lg \frac{\rho \cdot c}{(\rho \cdot c)_0}\right) \text{dB} \qquad (3)$$

where

$\overline{L_p}$ average sound pressure level;

S $\frac{\pi \times {d_0}^2}{4}$ the cross-sectional area of the test duct, in square metres;

S_0 1 m^2;

d_0 *diameter of test duct in m*

$(\rho \cdot c)_0$ 400 Ns/m^3.

ρ the density of the flue gas in kg/m^3

c the sonic speed of the flue gas in m/s

$$c = 20{,}1 \times \sqrt{T + 273}$$

T Flue gas temperature in °C

NOTE The flue gas temperature T and the pressure p relate to the measuring point at the heat generator outlet. The pressure p is the static pressure resulting from the ambient atmospheric pressure and the adjusted resistance from the throttle mechanism.

The A-weighted sound power level of the sound radiating into the test duct shall be determined in accordance with Annex C.

8 Test report

8.1 General data on appliance

The report shall contain at least the following information on the appliance tested:

— -type of appliance (wall-mounted, floor-standing and type of burner);

— -manufacturer, distributor, trade mark;

— -normal trade designation of the appliance;

— -manufacturer's number of the appliance;

— -nominal input;

— additional equipment and accessories;

— specification of fuel type or types.

8.2 Test equipment and test conditions

The report shall contain at least the following information on the test equipment and test conditions:

— test operating conditions (e. g. burner output setting, air figure, inlet and outlet water flow temperatures of the boiler, flue gas temperature, and flue gas pressure at outlet of the boiler);

— description of the ducts used including all lengths and cross-sectional areas or diameters, and of the anechoic termination measurement point as defined in 4.1;

— mounting arrangement of test appliance and measurement ducts etc.;

— acoustic environment (e.g. indoors or outdoors, air temperature, wind speed etc.);

— instrumentation details;

— fuel type used for test;

— electrical supply voltage;

— reference to the method of measurement used and/or deviations from this standard.

8.3 Test results

The following test results shall be stated:

— date the test was carried out;

— A-weighted sound power level L_{WA};

— standard deviation;

— sound power level in third-octave bands, L_{WTerz};

— measurement uncertainty (see Annex D).

Annex A
(informative)

Guidelines for the design and construction of an anechoic termination

A.1 The main characteristic of an anechoic termination is that the duct area widens gradually by a sufficient amount to prevent the sound wave from being reflected back into the duct, which would interfere with the sound level measurements. The criterion for meeting this requirement is defined in Table 3 as the maximum permissible pressure reflection coefficient. A procedure for checking whether these requirements are met is described in Annex B.

A.2 Figure A.1 and Figure A.2 are shown constructions which have been successfully used in some laboratories. Figure A.1 shows how the gradual change in the cross-sectional area of the duct approximates an exponential horn. As in most successfully tested anechoic terminations, part of the horn is filled with absorptive material in order to suppress the noises by the throttle and measurement equipment for the flow. This equipment is usually connected at the end of the horn. It is not necessary to copy the exponential profile slavishly. Approximations to this profile using conically graduated pipe sections as shown in Figure A.1 are adequate.

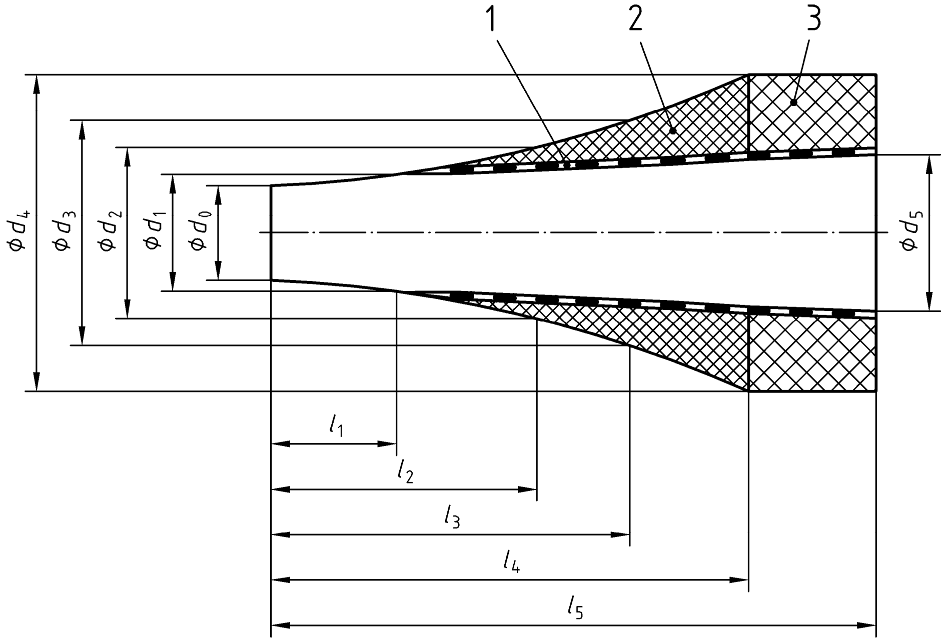
The other construction, shown in Figure A.2, is a stepped increase in the cross-sectional area of the absorption material.

A.3 As the inlet of the anechoic termination and the outlet of the duct form a smooth transition, the internal diameters are equal at the connection. All dimensions of the anechoic termination shall be stated as multiples of the internal diameter at the outlet from the measurement duct d_0. These dimensions are transferable to other duct diameters but only to a limited extent because the ratio of wavelength to diameter will be changed. The outer skin of termination can be made out of any suitable material that provides the structure with sufficient strength.

In the anechoic termination, the aerodynamic passage through the centre of the horn is outlined by perforated metal having about a 58 % open area. Particular attention should be paid to the smoothness of the transition at d_0. The space between the perforated metal and the conical sections of the horn is filled with mineral wool with a density of approximately 24 kg/m^3. The remaining cylindrical volume with a diameter of d_4 is filled with mineral wool with a density approximately 48 kg/m^3.

A.4 If transitions are to be used between the test duct and the anechoic termination, the transitions should be regarded as part of anechoic termination, meaning that the anechoic termination and the transitions taken together shall meet the requirements in Table 4.

A.5 The details of an anechoic termination with stepped expansion-sections are shown in Figure A.2. Sound is reflected every time the cross-section changes. The overall anechoic effect is achieved by defining the lengths of the sections in such a way that the reflected waves cancel out. Steps increasing in diameter by about 10 % and step lengths of about 0,3 m to 0,4 m are likely to be found suitable.



Key

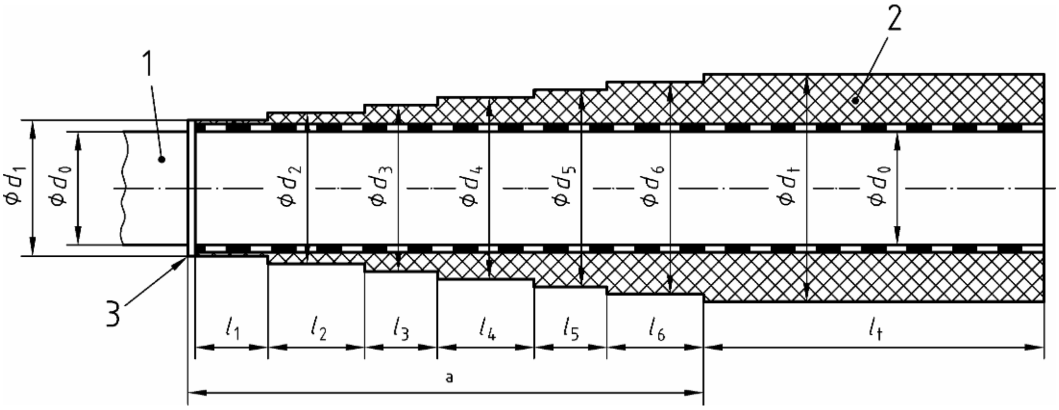
1 perforated metal, approximately 58 % open

2 mineral wool with a density of approximately 24 kg/m^3

3 mineral wool with a density of approximately 48 kg/m^3

Duct internal diameter d_0			
d_1 =	1,15 d_0	l_1 =	1,44 d_0
d_2 =	1,64 d_0	l_2 =	2,89 d_0
d_3 =	2,25 d_0	l_3 =	3,89 d_0
d_4 =	3,44 d_0	l_4 =	5,11 d_0
d_5 =	1,67 d_0	l_5 =	6,44 d_0

Figure A.1 — Example of an anechoic termination (tested for diameter d_0 = 0,46 m)



Key

1 test duct

2 Mineral wool with a density of 45 kg/m^3

3 flanged entry point

Measurement duct d_0	Serial no. of enlargement	d_1	l_1	d_2	l_2	d_3	l_3	d_4	l_4	d_5	l_5	d_6	l_6	End-piece d_T	End-piece length l_T
mm		Mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm
400	6	450	240	500	320	550	240	600	320	650	240	700	320	750	1.125
530	4	700	240	480	320	850	240	935	—	—	—	—	—	1.000	1.500
1.000	3	1.150	240	1.300	320	1.450	240	—	—	—	—	—	—	1.600	2.400

Figure A.2 — Example of a stepped anechoic termination

Annex B
(informative)

Testing of anechoic terminations

B.1 This annex shows an example of how the sound pressure reflection coefficient can be determined. The pressure reflection coefficient r_a, is calculated from the difference ΔL, between the maximum and minimum sound pressure levels occurring in the duct as a result of the standing wave formed by the incident and the reflected plane wave at each centre frequency of the frequency bands. This value should be calculated according to equation (B.1):

$$r_a = \frac{10^{\Delta L/20} - 1}{10^{\Delta L/20} + 1} \tag{B.1}$$

B.2 It is advisable to measure the pressure reflection coefficient for frequencies at which only plane-waves can be disseminated in the duct. It is only at frequencies less than f_0 (see equation (B.2)) that only plane-waves can occur in the duct:

$$f_0 = 0{,}586\ c/d_0 \tag{B.2}$$

where

c is the sonic speed in m/s

d_0 is the diameter of the test duct in m

with

$$c = 20\sqrt{T + 273}$$

where

T is the flue gas temperature in °C

The length of the test duct shall be at least 4 m.

B.3 A procedure for evaluating the anechoic termination performance is given below:

a) When the test duct has been connected to the anechoic termination, a high-quality loudspeaker is mounted at the entrance to the test duct on a plate that closes the duct.

b) Mechanism has to be provided by means of which the microphone can be moved along the entire length of the duct axis.

c) Apply a pure-tone signal from an audio oscillator to the loudspeaker, via an amplifier if necessary. The frequency should be equal to the centre frequency of the one-third-octave band.

d) Microphone signal is filtered with the aid of a narrow-band or one-third-octave band analyser and then apply the filtered output signal to a level recorder.

e) Microphone is moved along the axis of the test duct in order to measure the difference between the maximum and the minimum sound pressure levels.

f) Difference ΔL, between the maximum and the minimum sound pressure level is inserted into equation (B.1). The value obtained for r_{a}, is compared with the values shown in Table 4.

g) Steps c), d) and e) are repeated within the one-third-bands between 50 Hz and f_0.

h) If the anechoic termination is fitted with a throttle mechanism, Step g) is repeated with the throttle set at the maximum and then at the minimum pressure.

If no level recorder is available for d), the maximum and the minimum sound pressure levels can be recorded by hand.

B.4 Other procedures can also be used such as one with two microphones which is based on measuring the transfer function between the signals from two microphones situated in close proximity to one another.

Annex C
(normative)

Procedure for calculating the A-weighted sound power level from the octave band or one-third-octave band sound power levels

The A-weighted sound power level L_{WA} ,in decibels, can be calculated according to equation (C.1) (reference sound power level 1 pW):

$$L_{WA} = 10 \cdot \lg \sum_{j_{min}}^{j_{max}} 10^{0,1\left((L_W)_j + C_j\right)} \text{ dB} \quad \text{(C.1)}$$

where:

$(L_W)_j$ is the level in the j-th one-third band

j_{max} = 27

The values for C_j are shown in Table C.1.

Table C.1 — Values for C_j in accordance with EN 61672-1

j	one- third octave-band centre nominal frequency Hz	C_j dB
1	50	–30,2
2	63	–26,2
3	80	–22,5
4	100	–19,1
5	125	–16,1
6	160	–13,4
7	200	–10,9
8	250	–8,6
9	315	–6,6
10	400	–4,8
11	500	–3,2
12	630	–1,9
13	800	–0,8
14	1.000	0
15	1.250	+0,6
16	1.600	+1,0
17	2.000	+1,2
18	2.500	+1,3
19	3.150	+1,2
20	4.000	+1,0
21	5.000	+0,5
22	6.300	–0,1
23	8.000	–1,1
24	10.000	–2,5
25	12.500	–4,3
26	16.000	–6,6
27	20000	–9,3

Annex D
(informative)

Uncertainty of the measurement process

The measurement uncertainty has to be calculated using the analysed data.

When the sound power is being determined in accordance with this standard, there is usually a degree of uncertainty in measuring the sound power level and this is shown in Table D.1 as a comparative standard deviation. The standard deviations shown in Table D.1 takes into account the overall effect of all the factors affecting measurement uncertainty such as the installation location of the sound source, reflections at the end of the duct transition, the calibration of the measuring equipment, and in the readings themselves.

The Table D.1 shows those standard deviations that would be expected if the measurements were repeated on one single heat generator in a number of different laboratories.

Table D.1 — Standard deviation values

One-third-octave band centre frequency Hz	Standard deviation of reproducibility dB
50	3,5
63	3
80 to 100	2,5
125 to 4 000	2
5 000	2,5

The standard deviations shown in Table D.1 relate to the conditions under which readings are taken and the methods used, not to the source of sound itself. They result partly from deviations in the geometry of the measuring set-up, such as can emerge between one test location and another, from background noises, and from differences in the construction and calibration procedures of the measuring instruments used. They are also caused by differences in measurement technique such as spatial averaging and averaging times.

Some guidance is given in EN ISO 5136:2003.

Bibliography

[1] EN ISO 5136:2003; *Acoustics — Determination of sound power radiated into a duct by fans and other air-moving devices — In-duct method (ISO 5136:2003).*

[2] EN 267, *Forced draught oil burners — Definitions, requirements, testing, marking*

[3] EN 676, *Automatic forced draught burners for gaseous fuels*

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