

Methods for

# Testing and rating terminal reheat units for air distribution systems —

Part 2: Acoustic testing and rating

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- Boiler and Radiator Manufacturers Association Limited\*
- British Combustion Equipment Manufacturers Association
- British Gas Corporation
- British Refrigeration and Air Conditioning Association\*
- Building Services Research and Information Association\*
- Chartered Institution of Building Services\*
- Department of the Environment (PSA)
- Department of Health and Social Security\*
- Electricity Supply Industry in England and Wales
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- Ministry of Defence\*
- National Coal Board
- Society of British Gas Industries
- Water-tube Boilermakers' Association

The organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Department of the Environment — Building Research Establishment
- Institute of Domestic Heating Engineers
- Portsmouth Polytechnic

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## Foreword

This Part of this British Standard has been prepared under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee in response to requests from industry.

The committee acknowledge their debt to the Building Services Research and Information Association for the Association's work in formulating the methods of testing that appear in this standard. It is intended to review this standard when a series of ISO standards dealing with acoustic testing has been completed and published as British Standards.

Where reference is made to British Standards for which no metric version is available, the appropriate British Standard in imperial units should be used in conjunction with BS 350. Attention is also drawn to BS 3763 and PD 5686.

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### Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 20, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

## Section 1. General

### 1 Scope

This Part of this British Standard deals with methods of acoustic testing and rating of terminal reheat units, defined in Part 1 of the standard, for:

- a) static terminal attenuation;
- b) sound generation, upstream and downstream of the unit;
- c) radiation of sound from the casing.

### 2 References

The titles of the publications referred to in this standard are listed on the inside back cover.

### 3 Definitions

For the purposes of this British Standard the definitions of acoustic terms given in BS 661 apply; other definitions given in BS 4857-1, together with the following, also apply.

#### 3.1

##### **dummy load**

a flow restrictor or similar device having the same pressure/flow characteristic as the unit under test

#### 3.2

##### **insertion loss**

the insertion loss of a terminal reheat unit is the attenuation it gives to noise propagated from the system through the supply duct. It is defined here as the difference between the sound power radiated from, the open end of the supply duct, and that radiated when the unit is connected to this supply duct. The test is conducted without air flow to determine the static insertion loss

#### 3.3

##### **noise radiated in direction of inlet**

the rate at which sound energy enters a uniform airway connected to the unit inlet

#### 3.4

##### **noise radiated in direction of outlet**

the rate at which sound energy enters a uniform airway connected to the unit outlet

#### 3.5

##### **steady state conditions**

steady state conditions are considered to exist for test purposes if the air volume flow rate does not vary by more than  $\pm 2\%$  from a mean value during the test

#### 3.6

##### **terminal attenuation**

terminal attenuation is the difference between the sound power level in the supply inlet duct and the sound power level in the outlet duct. Terminal attenuation can be calculated from the insertion loss by adding the outlet duct and reflection and subtracting the inlet duct end reflection

## 4 Nomenclature

| Symbol | Quantity                                            | Unit |
|--------|-----------------------------------------------------|------|
| $P$    | Sound pressure                                      | Pa   |
| $P_0$  | Reference sound pressure ( $= 2 \times 10^{-5}$ Pa) | Pa   |
| $L_p$  | Sound pressure level                                |      |
|        | $= 20 \log_{10} \frac{P}{P_0}$                      | dB   |
| $W$    | Sound power                                         | W    |

|           |                                         |                |
|-----------|-----------------------------------------|----------------|
| $W_0$     | Reference sound power ( $= 10^{-12}$ W) | W              |
| $L_W$     | Sound power level                       |                |
|           | $= 10 \log_{10} \frac{W}{W_0}$          | dB             |
| $A$       | Octave band terminal attenuation        | dB             |
| $T$       | Reverberation time of the test room     | s              |
| $\alpha$  | Random incident absorption coefficient  | —              |
| $V$       | Volume of the test room                 | m <sup>3</sup> |
| $S$       | Surface area of the test room           | m <sup>2</sup> |
| $\lambda$ | Wavelength of sound                     | m              |
| $X_r$     | End reflection                          | dB             |

NOTE In the text, mean values are indicated by a bar over the symbol.

## 5 General test requirements

**5.1** The tests shall be carried out in accordance with the conditions and methods specified in section 2, unless otherwise specified in section 1.

**5.2** Multiple outlet boxes shall be tested with a single outlet duct fitted. This single duct shall have an outlet area equal to the sum of the areas of the multiple outlets.

**5.3** Units designed for use in a specific situation shall be tested under conditions simulating this situation.

## 6 Instrumentation

Instrumentation shall comply with the provisions of section 2 and of BS 4857-1.

## 7 Test methods

### 7.1 Terminal attenuation

**7.1.1** The unit shall be connected to a system similar to that shown in Figure 1. The minimum dimension of the chamber shown shall be three and a half times the air supply duct diameter (or mean of sides if rectangular).

**7.1.2** A suitable random noise source is either:

- a) a loud-speaker connected to a random noise generator;
- b) the reference sound source described in section 2.

Where a tape recording is used for the noise source, precautions shall be taken to ensure that the output remains constant throughout the duration of the test. A closed loop tape is recommended to minimize the effects of tape sensitivity variations and the loop should pass the play-back head at least three times during each frequency band measurement. The tape should be of the type recommended for closed loop working, i.e. with a permanently lubricated surface.

**7.1.3** Background noise levels shall be measured with the sound source operating during both unit-in and unit-out tests. These levels should be more than 6 dB below the measured mean sound pressure levels (see also clause 19).

If the background noise level is less than 6 dB below the mean sound pressure level measured during the unit-in test then this will reduce the measured insertion loss. Where this occurs the results shall be reported with a note to this effect.

A correction for the intrusion of background noise affecting the measurements of sound pressure level with the equipment operating shall be applied for the condition indicated in Table 1.

NOTE For measurement of noise of quiet equipments, see Appendix A.

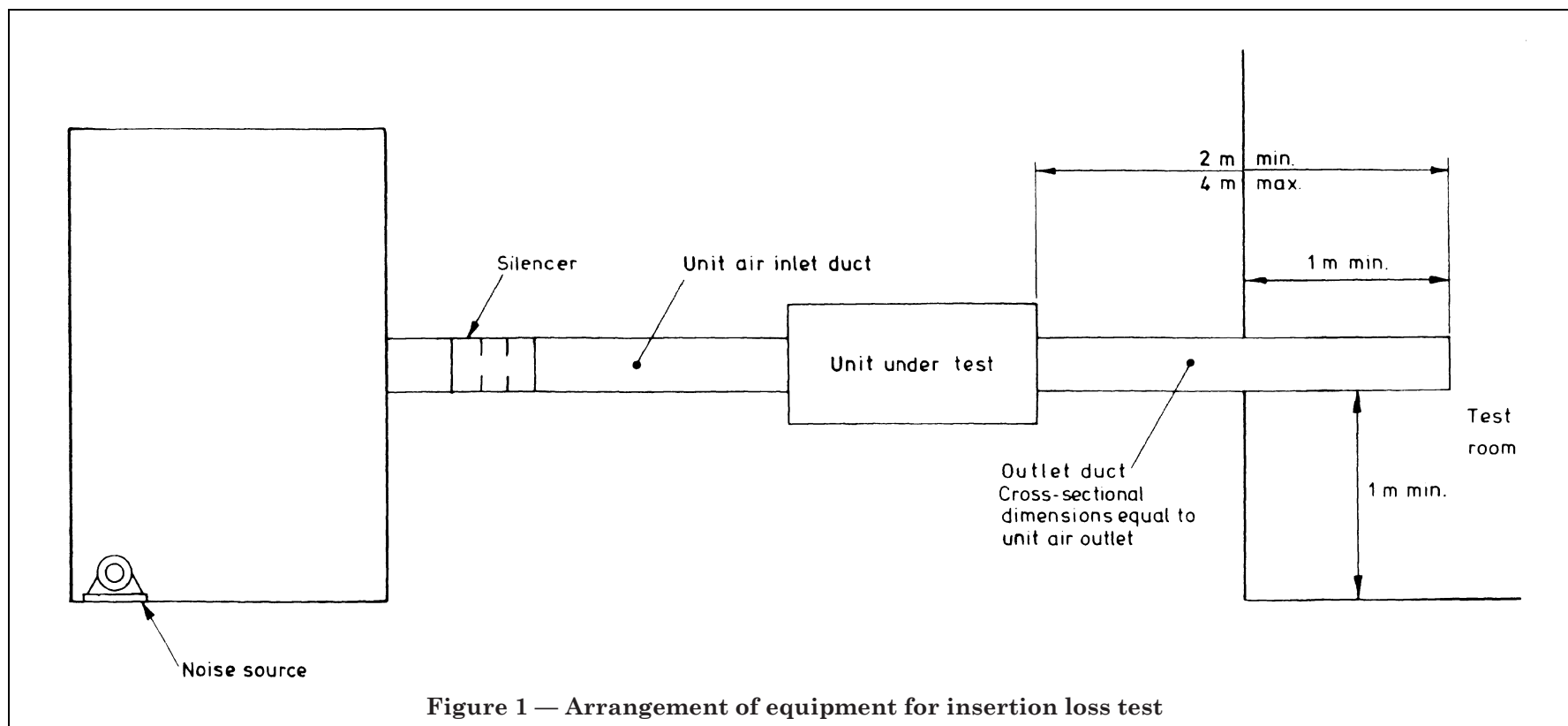


Figure 1 — Arrangement of equipment for insertion loss test

Table 1 — Correction conditions for background noise

| Increase in room sound pressure level produced by equipment operation                                                                                                                                                                                                                                    | Correction                                                                          |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|
| dB                                                                                                                                                                                                                                                                                                       |                                                                                     |
| 0 to 5 <sup>a</sup>                                                                                                                                                                                                                                                                                      | No correction permitted but results may be reported as affected by background noise |
| 6 to 8                                                                                                                                                                                                                                                                                                   | Subtract 1 dB from measured $\overline{L}_P$                                        |
| Above 8                                                                                                                                                                                                                                                                                                  | No correction                                                                       |
| <sup>a</sup> The presence of a discrete frequency component in any one-third octave band means that any measurements in this band are of doubtful value. Measurements may be made in either one-third or one octave bands not containing the discrete frequency, and these will have the usual accuracy. |                                                                                     |

7.1.4 The test shall be carried out as follows.

- With the unit installed as shown in Figure 1 and the noise source operating, measure the mean sound pressure level, in octave bands, in the test room,  $\overline{L}_{Pi}$ .
- Remove the unit and substitute a length of straight duct as shown in Figure 2.
- Repeat test a) maintaining the output of the noise source constant. This gives  $\overline{L}_{Po}$ .

7.1.5 The terminal attenuation  $A$  shall be calculated from the following equation.

$$A = \overline{L}_{Po} - \overline{L}_{Pi} + X_{ro} - X_{ri}$$

where

$\overline{L}_{Pi}$  is the measured mean sound pressure level for the unit-in test (in dB)

$\overline{L}_{Po}$  is the measure of mean sound pressure level for the unit-out test (in dB)

$X_{ri}$  is the end reflection obtained from Figure 3 for the terminal duct dimension for the unit-in test (in dB)

$X_{ro}$  is the end reflection obtained from Figure 3 for the terminal duct dimension for the unit-out test (in dB)

7.1.6 Noise from the source which may reach the microphone measuring stations without passing through the unit under test (flanking transmission) will appear to reduce the terminal attenuation of the unit. The following procedure shall be carried out to determine whether this is occurring.

- Measure the octave band sound pressure level in the same way as for the unit-in test with the sound source operating.
- Block the inlet duct with a high transmission loss barrier immediately upstream of the unit and repeat test a).

If the octave band sound pressure level measured under b) is at least 10 dB below that measured under a) in each band of concern, the terminal attenuation measurements made on the unit will not be affected by such flanking transmission.

## 7.2 Generated noise

7.2.1 *General.* The tests described in this clause are for the determination of air flow generated noise radiated through both the inlet and outlet connections.