

Methods for

Testing and rating terminal reheat units for air distribution systems —

Part 1: Thermal and aerodynamic
performance

UDC 697.978:697.356.001.42

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- Department of the Environment, Building Research Station
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- Oil Appliances Manufacturers Association
- Steel Radiators & Convector Manufacturers Association
- Unit Heater Manufacturers Association

This British Standard, having been approved by the Refrigeration, Heating and Air Conditioning Industry Standards Committee, was published under the authority of the Executive Board on 11 October 1972

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The following BSI references relate to the work on this standard:
Committee reference RHE/6
Draft for comment 71/30799

ISBN 0 580 07323 8

Amendments issued since publication

Amd. No.	Date of issue	Comments

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Foreword

This Part of this British Standard has been prepared under the authority of the Refrigeration, Heating and Air Conditioning Industry Standards Committee to meet the needs expressed by industry and is the first Part of a two Part standard. Part 2, dealing with acoustic testing and rating, will be published later.

The Committee acknowledge their debt to the Heating and Ventilating Research Association for the Association's work in formulating the methods of testing that appear in this standard.

The test methods presented in this Part of the standard will enable the thermal and aerodynamic performance of a terminal reheat unit to be evaluated at any water and air flow rate and temperature within the range of variables employed for the test. The air flow tests are carried out in accordance with BS. . . ., "*Testing and rating of air control devices for air distribution systems, Part 1, "Aerodynamic testing of constant flow rate assemblies without a heat exchanger"*".¹⁾

Two heat transfer test methods are given in the standard, one for operation over a limited range of temperatures and one for a wider range of temperatures.

Examples of the use of the test data are also presented.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 16, 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.

¹⁾ In course of preparation.

1 Scope

This Part of this British Standard describes methods of thermal and aerodynamic testing and rating for high pressure terminal reheat units with or without flow rate controllers. It describes the equipment required and gives instructions for the calculation, interpretation and interpolation of results.

2 Definitions

For the purposes of this British Standard, the following definitions apply:

2.1

terminal reheat device

an assembly consisting of a heat exchanger within a casing, having one air inlet. The casing may also contain some or all of the following components:

- a) a manual damper;
- b) a constant flow rate controller;
- c) a sound attenuator.

the casing is so designed that the whole of the air discharged from the device is obtained from the inlet duct

NOTE When the device contains a constant flow rate controller, it is normally referred to as a single duct terminal reheat box. When the device contains a manual damper, it is normally referred to as a terminal reheat unit.

2.2

flow rate controller

a device mounted within the casing for the purpose of maintaining a constant air-flow rate through the casing when the pressure differential between high and low pressure sides varies within the limits for which the equipment is designed

NOTE A flow rate controller normally maintains a constant air-flow rate to within $\pm 5\%$ of the maximum air-flow rate of the device, within the pressure differential range of about 200 N/m^2 (2 mbar) to $1\,500 \text{ N/m}^2$ (15 mbar).

there are different types of flow rate controllers, such as:

- a) *Mechanical constant flow rate controller*. Self-actuating. This type derives its power from the air stream and not from any external source.
- b) *Mechanical variable flow rate controller*. As for a) above, but with its flow rate varied by an external signal.
- c) *Pneumatic, electric, etc., flow rate controllers*. Controllers deriving their power from an external source. They can be either of the constant or variable type.

3 Nomenclature

Symbol	Definition	Units
A_i	Area of air inlet duct	m^2
A_t	Area of water supply tube	m^2
c_p	Specific heat capacity	$\text{kJ/kg } ^\circ\text{C}$
H_D	Hydraulic diameter ($= 4 \times \text{area/perimeter}$)	m
K_w	Temperature correction factor	—
m	Water mass flow rate	kg/s
p	Pressure relative to atmosphere	N/m^2
Δp	Pressure drop	N/m^2
Δp_c	Hydraulic pressure drop at $80\text{ }^\circ\text{C}$	N/m^2
Δp_m	Measured hydraulic pressure drop corrected for height difference	N/m^2
p_b	Atmospheric pressure	bar
Q	Heat transferred	kW

Symbol	Definition	Units
ρ	Density	kg/m ³
t	Temperature	°C
U	Air velocity	m/s
V	Air volume flow rate	m ³ /s

Suffixes

a	inlet air
i	inlet water
o	outlet water
f	flow meter
r	reference air
s	static pressure
w	water

Reference conditions for air:	Temperature	20 °C
	Pressure	1013.25 mbar (101.325 kN/m ²)
	Density	1.2 kg/m ³
	Relative humidity	43 %

4 Instrumentation

4.1 Temperature

4.1.1 The measurement of temperature shall be by means of mercury-in-glass thermometers, resistance thermometers or the thermocouple and potentiometer. Temperature measuring instruments shall comply with the requirements of BS 1041.

4.1.2 The water temperature at entry and exit shall be measured by means of instruments inserted in oil-filled pockets similar to those shown in Figure 1. If mercury-in-glass thermometers are used they shall comply with the requirements of BS 593 partial immersion ranges, and shall be graduated in intervals not exceeding 0.1 °C.

4.1.3 All temperature measuring instruments shall be calibrated to an accuracy of 0.1 °C.

4.2 Water flow measurement

4.2.1 The measurement of water flow shall preferably be by means of direct weighing (for water temperatures above 90 °C it would be advantageous to use one of the methods described in BS 1042 Part 1). The water leaving the test rig shall be collected in vessels of known weight, and weighed on a beam-type weighing machine, having an accuracy of 0.1 % over the range of weight used in the test. The weight of each vessel used shall not exceed 50 % of the weight of its normal contents. Means shall be taken to minimize evaporation from the vessels awaiting weighing. The net weight of each charge shall be recorded by weighing the vessel both after emptying the previous charge and after filling.

4.2.2 The above method is suitable for water exit temperatures up to about 90 °C using the arrangement of equipment shown in Figure 2. For higher water exit temperatures it may be necessary to cool the water leaving the unit before it is discharged into the measuring vessel. Care shall be taken to check any after-cooler for leaks.

4.2.3 An alternative to the method of direct weighing described in 4.2.1 is shown in Figure 3, together with a suitable water supply system for water temperatures above 90 °C.

4.3 Air flow measurement

Air flow measurement shall comply with the requirements of BS 1042-1 or alternatively, a flow meter may be calibrated in situ using the methods given in BS 1042-2²⁾.

4.4 Manometers

4.4.1 The minimum differential pressure measurement for air flow measurement shall be 25 N/m² for inclined U-tube manometers and micromanometers and 500 N/m² for vertical U-tube manometers.

4.4.2 All manometers shall be calibrated against an accepted standard.

4.4.3 It shall be possible to read all manometers to 1 % of the indicated reading.

5 Test for casing leakage

This test shall be carried out in accordance with BS ²⁾. In the case of units fitted with a flow control device, leakage tests shall be carried out with this device in the open position.

6 Test of constant flow rate controller characteristics

Units fitted with a constant flow rate controller shall be tested for the performance of the constant flow rate controller by the method described in BS ²⁾.

7 Test for air flow pressure characteristics

Units fitted with a manual or remote controlled air flow damper shall be tested for the relationship between the inlet total pressure and air volume flow rate, with the damper set in the fully open position.

7.1 An air inlet duct of internal dimensions equal to the nominal dimensions of the inlet of the unit under test, and of a minimum straight length 5½ hydraulic diameters, shall be fitted to the unit inlet. A ring of four wall static taps (constructed to BS 1042-2²⁾) shall be fitted at a point 1½ inlet duct hydraulic diameters from the unit inlet; a flow straightener shall be fitted 4 hydraulic diameters and a wire screen 3 hydraulic diameters upstream from the static taps. The unit and duct assembly shall be connected to an air flow meter, fan and flow control system as shown in Figure 4.

7.2 The inlet air temperature shall be measured at a point, ½ hydraulic diameter downstream of the static taps, at the four stations indicated in the inset diagram in Figure 4. The inlet air temperature (t_a) shall be the mean of these four measurements.

7.3 The desired air flow shall be set and when steady state conditions have been achieved measurements of the following shall be recorded.

NOTE For the purposes of this test steady state conditions are said to exist when the inlet air temperature has not varied by more than 0.25 °C and the flow meter pressure drop and static pressure at the unit inlet have not varied by more than 2 % over a period of 5 min.

Δp_f flow meter pressure drop (N/m²)

p_{s_f} static pressure upstream of the flow meter (N/m²)

t_f the temperature at the flow meter (°C)

p_s the unit inlet static pressure (N/m²)

t_a the unit inlet temperature (mean of four) (°C) and

p_b the atmospheric pressure (bar).

The air volume flow rate at the flow meter (V_f) is calculated from Δp_f , p_{s_f} , t_f , and p_b .

The mean velocity at the unit inlet (U_i), is calculated from the following equation.

$$U_i = \frac{V_f}{A_i} \times \frac{\rho_f}{\rho_i}$$

where A_i is the area of the inlet duct (m²)

ρ_f is the density of air at the flow meter (kg/m³)

ρ_i is the density of air at the unit inlet (kg/m³).

²⁾ BS "Testing and rating of air control devices for air distribution systems", Part 1, "Aerodynamic testing of constant flow rate assemblies without a heat exchanger". (In course of preparation.)