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**Introduction**

Your comments on this draft are invited and will assist in the preparation of the consequent standard.

For international and European standards, comments will be reviewed by the relevant UK national committee before submitting the consensus UK vote and comments. If the draft standard is approved, it is usual for the resulting published standard to be adopted as a British Standard.

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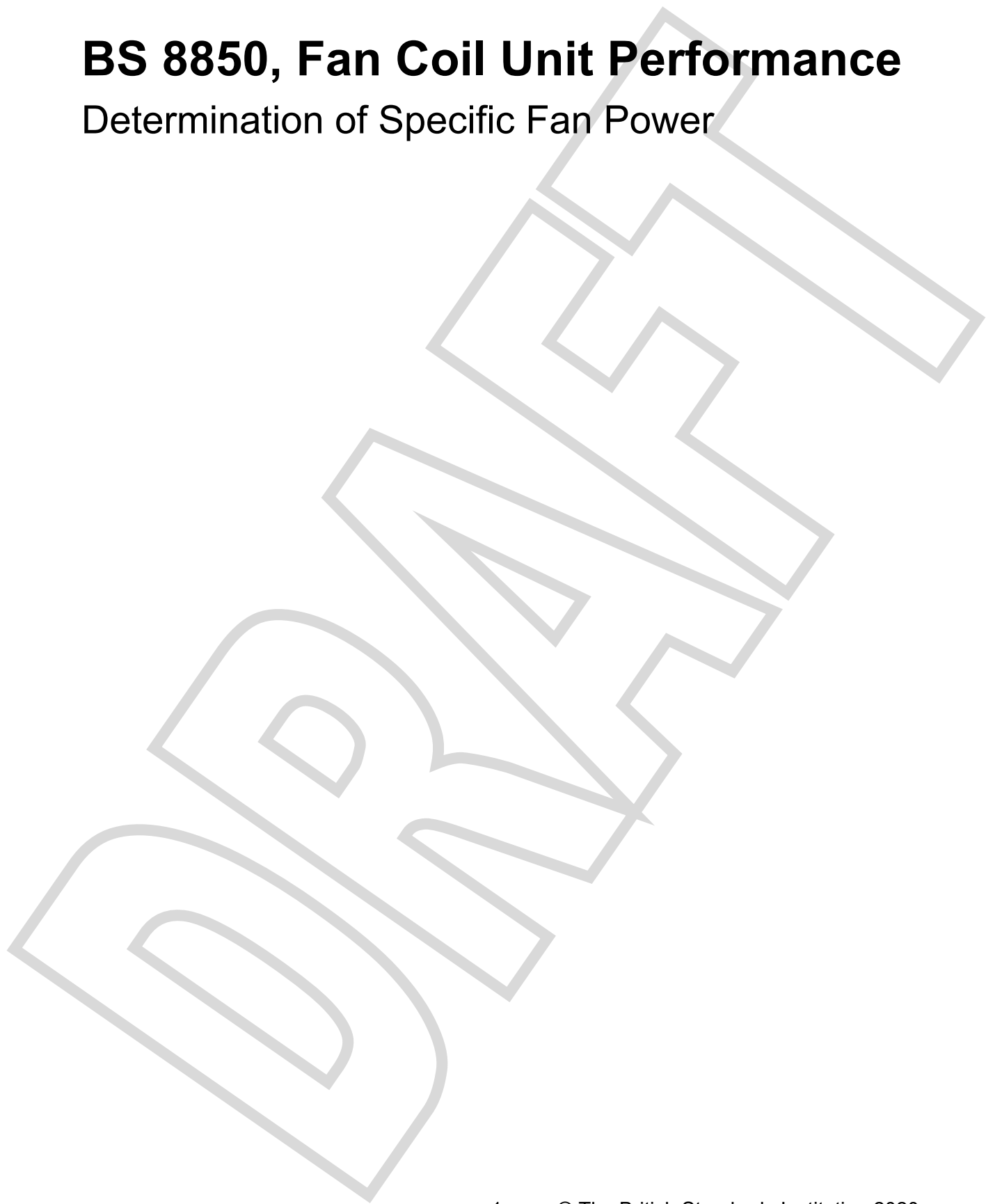
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# **BS 8850, Fan Coil Unit Performance**

## Determination of Specific Fan Power



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## **BS 8850:2020**

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## Foreword

### Publishing information

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### Information about this document

This element gives, as appropriate:

- information relating to the structure of the standard;
- any problems in preparation (e.g. matters omitted).

### Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its methods are expressed as a set of instructions, a description, or in sentences in which the principal auxiliary verb is “shall”.

*Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.*

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### Contractual and legal considerations

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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## 1 Scope

This British Standard sets out a controlled method to determine Specific Fan Power (SFP) of Fan coil units (FCU) as a function of the volume flow rate of air.

This British Standard covers ducted, non-ducted and cassette FCUs that can be standing on the floor, hung on the wall, or fitted into the ceiling or floor, with the inlet and outlet air sections located either on the front, back, bottom or top of the unit.

This British Standard also defines FCU configuration for test purposes.

## 2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document<sup>1)</sup>. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN ISO 5801, *Fans – Performance testing using standardized airways*

BS EN ISO 16890 (all parts), *Air filters for general ventilation*

BS EN 1397, *Heat exchangers – Hydronic room fan coil units – Test procedures for establishing the performance*

BS EN 16798-3 *Energy performance of buildings-Ventilation for buildings – For non-residential buildings – Performance requirements for ventilation and room-conditioning systems (Modules M5-1, M5-4)*

PD CEN/TS 17153, *Ventilation for buildings – Correction of air flow rate according to ambient conditions*

## 3 Terms, definitions and symbols

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

### 3.1 Terms and definitions

#### 3.1.1 external static pressure

positive pressure difference measured between the air outlet and inlet sections of the unit

#### 3.1.2 fan coil unit (FCU)

##### 3.1.2.1 fan coil unit

factory-made single assembly providing one or more of the functions of forced circulation of air, heating, cooling, dehumidification and filtering of air, but which does not include the source of heating or cooling

*NOTE 1 This device includes a liquid-to-air heat exchanger, inlet filter and a fan, and can be designed for free or ducted intake air and/or free or ducted delivery of supply air.*

*NOTE 2 Annex A provides a series of drawing schemes associated to designations to show typical existing configurations.*

##### 3.1.2.2 ducted fan-coil unit

fan coil unit designed for free or ducted intake air with ducted delivery of supply air from integral discharge plenum

*NOTE 1 Plenum can be fitted with single or multiple connection points, rectangular or circular.*

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<sup>1)</sup> Documents that are referred to solely in an informative manner are listed in the Bibliography.

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*NOTE 2 Any fan coil that is connected to a secondary air distribution system is classified as a ducted fan-coil unit.*

*NOTE 3 See Annex A for examples of ducted fan-coil units.*

### **3.1.2.3 non-ducted fan coil and cassette unit**

designed for free intake air and free delivery of supply air

*NOTE 1 See Annex A for examples of non-ducted fan-coil units.*

*NOTE 2 Annex A provides a series of drawing schemes associated to designations to show typical existing configurations.*

### **3.1.3 inlet air filter**

replaceable filter panel installed on the inlet of the FCU to provide protection to internal components.

*NOTE Filter classification should be in accordance with BS EN ISO 16890.*

### **3.1.4 rating condition**

#### **3.1.4.1 mandatory rating conditions**

conditions used for comparison purposes

#### **3.1.4.2 project-specific optional rating condition**

condition where test parameters fall outside the mandatory rating

*NOTE See Table 1.*

### **3.1.5 specific fan power**

amount of electric fan power divided by the air volume flow

### **3.1.6 total electric power input**

total electric power absorbed by the FCU including fan(s), inverters and EMC filter but excluding any electrical resistance heater, valves, actuators, FCU controller or building management system (BMS) controls

*NOTE This British Standard excludes power consumption associated with auxiliary FCU controllers, valves, actuators or BMS controls. Typically, controls are excluded from the FCU manufacturer's supply therefore power consumption cannot be considered within this British Standard.*



### 3.2 Symbols

Symbol	Description	Unit
$P_{elec}$	Total input powers of the motor(s) for the fan(s)	W
$P_{atm}$	Atmospheric pressure	kPa
$p_A$	External static pressure	Pa
$P_{SFP}$	Specific fan power	W·l/s
$q_{vtest}$	Measured volume flow rate of air	l/s
$q_{vref}$	Volume air flow rate through the fan in l/s, corrected to standard conditions (see 4.11.1)	l/s
$t_A$	Air inlet dry bulb temperature	°C
$t_{Aw}$	Air inlet wet bulb temperature	°C
$\Delta P_{coil}$	Static differential air pressure across the heat exchanger	Pa
-	Voltage	V
$f$	Frequency	Hz

## 4 Test to determine specific fan power

### 4.1 Principle

The determination of the parameters for specific fan power shall be in accordance with this British Standard and BS EN 1397.

The specific fan power ( $P_{SFP}$ ) of fan FCUs, ducted, non-ducted and cassette shall be determined by measuring total electric power absorbed ( $P_{elec}$ ) and volume flow rate of air ( $q_v$ ) when operating at the mandatory or project specific external static pressure.

### 4.2 Test sample

For testing, the unit shall include an inlet air filter in accordance with BS EN ISO 16890-3, ISO coarse 30%, but no other accessory for air inlet or diffusion or others. Dampers for fresh air intake shall be closed.

Inlet or outlet cover grilles shall be included within the test where supplied with non-ducted and cassette units.

Modifications to the standard unit, such as sealing, shall not be made on the unit before testing.

### 4.3 Apparatus

**4.3.1 Fan coil unit**, including flaps, adjusted in a fixed position in accordance with the manufacturer's instructions. If this information is not available, the flaps shall be in the maximum mechanical open position.

*NOTE 1* The maximum mechanical open position might differ from the minimum airflow resistance.

*NOTE 2* A voltage stabilizer might be required between the incoming electrical supply and the FCU under test.

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**4.3.2** *Liquid to air heat exchanger*, in accordance with the manufacturer's standard design.

**4.3.3** *Test chamber*, in accordance with BS EN ISO 5801, Category B.

**4.3.4** *Volume air flow measurement station*, in accordance with BS EN ISO 5801, Category B.

**4.3.5** *Auxiliary fan*, in accordance with BS EN ISO 5801, Category B, capable of overcoming pressure losses through the test setup, and equipped with adjustment means, such as dampers, pitch control, or speed control to vary the capacity.

**4.3.6** *Power meter*, in accordance with BS EN ISO 5801:2017, **12.4.2**.

**4.3.7** *Digital power meter*, greater than 0.5% accuracy and bandwidth high enough to measure up to and including the 50<sup>th</sup> harmonic.

**4.3.8** *Manometer*, in accordance with BS EN ISO 5801:2017, **12.8.2–12.8.5**.

All monitoring and measurement equipment used during testing shall be calibrated by a UKAS-accredited test laboratory.

#### 4.4 Test room

The test room shall be of sufficient volume and circulate air in such a manner that it does not change the normal return air circulating pattern of the FCU.

Air velocities at a distance of 0.5 m from the air inlet section area of the FCU shall not exceed 0.5 m/s when the unit is not operational.

For all units, dimensions shall be such that the distance from any room surface to any surface of the FCU from which air is discharged is not less than 1.5 m.

The distance from any other room surface or any other surface of the unit shall not be less than 1 m, except for floor, ceiling or wall required for normal installation in accordance with the manufacturer's instructions.

*NOTE* See Annex A for examples of different types of configurations of FCUs.

#### 4.5 Mandatory rating conditions

Rating conditions shall be in accordance with Table 1.

**Table 1 – Rating conditions**

	Mandatory rating	Project-specific rating	Unit
Voltage	230	216–253	V
Frequency	50	50–60	Hz
Air inlet dry bulb temperature	18–24	10–30	°C
External static pressure – ducted	30	0–200	Pa
External static pressure – non-ducted	0	0	Pa
Inlet air filter	BS EN ISO 16890-3, ISO Coarse ≥ 30%	As required	—

Testing of the FCU shall cover the full operational voltage range of the FCU.

Sufficient readings shall be taken to allow the full  $P_{SFP}$  characteristics to be determined as a function of volume air flow rate.

Extrapolation of results shall not be permitted.

#### **4.6 Test installation**

**4.6.1** The FCU shall be installed in the test room in accordance with the manufacturer's instructions, using recommended installation procedures. Installation should not contravene limitations in accordance with **4.4**. Where specific installations result in installation distances outside the requirements of **4.4**, this shall be recorded and qualified within the test report.

#### **4.7 Ducted fan coil measurement test method**

##### **4.7.1 Installation**

The installation shall be in accordance with:

- a) outlet method (see **4.7.3**): Figure 1; or
- b) inlet method (see **4.7.5**): Figure 2.

##### **4.7.2 Steady state conditions**

Steady state conditions shall be obtained and maintained when all the measured quantities remain constant without having to alter the set values in accordance with the tolerances in Table 2.

Testing shall not commence until steady state conditions have been achieved in accordance with the tolerances in table 2.

Readings shall be taken and averaged over a 10 min period.

**Table 2 – Permissible deviations for set values**

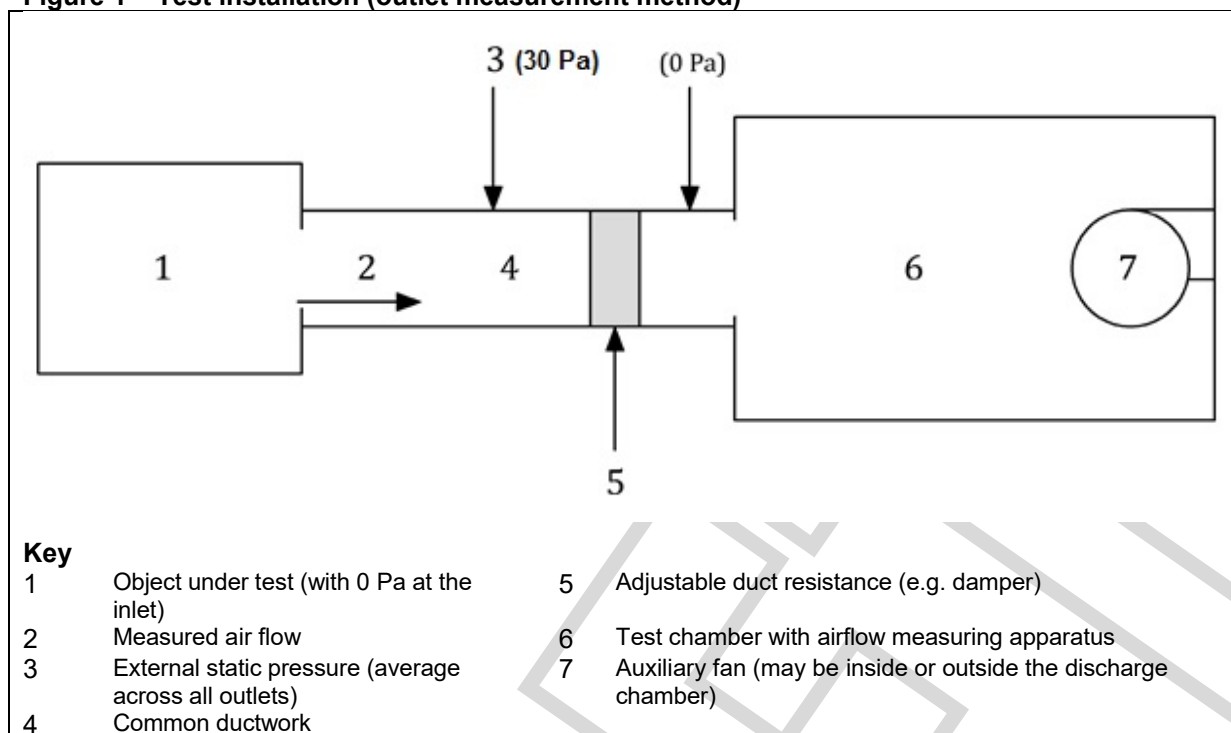
<b>Measured quantity</b>	<b>Permissible deviation of the arithmetic mean values from set values</b>	<b>Permissible deviations of time-individual measured values from set values</b>
Ambient air: dry bulb temperature	±2 K	±5 K
Mains input voltage	±1%	±2%
External static pressure	±1 Pa	±5 Pa
Volume flow rate	±2%	±5%

##### **4.7.3 Outlet measurement installation**

Installation using the the outlet measurement method shall be in accordance with Figure 1 and as follows.

- a) Install the FCU [see Figure 1, 1)] outside the test chamber [see Figure 1 6)].
- b) Use an auxiliary fan [see Figure 1, 7)] to maintain 0 Pa within the test chamber [see Figure 1, 6)].
- c) Control the FCU external static pressure between the FCU discharge and adjustable duct resistance [see Figure 1, 5)] and measure within the FCU discharge ductwork [See Figure 1, 4)] (after connection spigots).
- d) Measure the volume airflow rate from the FCU discharge within the test chamber [see Figure 1, 6)].

**Figure 1 – Test installation (outlet measurement method)**



#### 4.7.4 Test procedure (outlet method)

*NOTE* See Figure 1.

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**4.7.4.1** All discharge connections of the FCU shall be connected to common ductwork, including a damper for adjusting the external static pressure (see Figure 1).

**4.7.4.2** Common ductwork shall be connected to the test chamber, installed with a flow measuring device in accordance with BS EN ISO 5801.

**4.7.4.3** External static pressure shall be recorded as an average across all discharge duct connections at a distance of no less than 500 mm from the FCU.

**4.7.4.4** The FCU shall be disconnected from the cooling or heating power supply or the liquid circulation stopped.

**4.7.4.5** The auxiliary fan (see 4.3.5) shall be adjusted to maintain 0 Pa within the test chamber.

**4.7.4.6** The adjustable duct resistance, e.g. damper (see Figure 1) shall be adjusted to achieve the mandatory or project-specific rating condition (external static pressure) in accordance with Table 1.

**4.7.4.7** With the FCU in operation, and once steady state conditions are achieved in accordance with Table 2, measurements in accordance with Table 3 shall be recorded.

**Table 3 – Data to be recorded**

	Symbol	Unit
FCU model	–	–
Test volume air flow rate	$q_{vtest}$	l/s
Inlet filter class	–	–
Outlet configuration (size / qty)	–	–
Atmospheric pressure	$P_{atm}$	kPa
Voltage	–	V
Frequency	$f$	Hz
Speed control setting of the fan	–	Vdc
Total input power for the motor(s) for the fan(s)	$P_{elec}$	W
Air inlet dry bulb temperature	$t_A$	°C
Air inlet wet bulb temperature	$t_{AW}$	°C
External static pressure	$p_A$	Pa
Static differential air pressure drop across the heat exchanger	$\Delta P_{coil}$	Pa

*NOTE 1 For the measurement of static differential air pressure drop across the heat exchanger, see 4.9.*

*NOTE 2 For information relating to variable air volume (VAV) operation, see Annex B.*

#### **4.7.5 Inlet measurement installation**

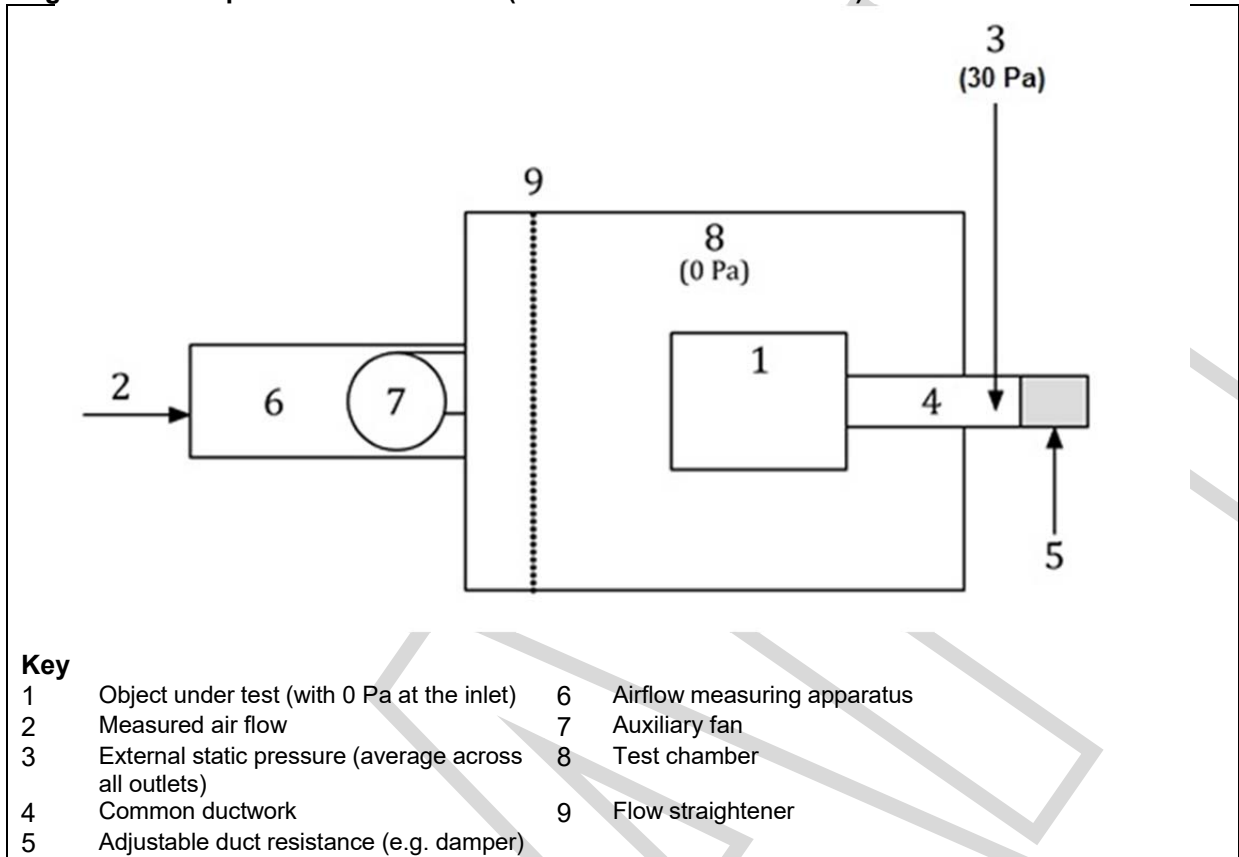
Installation using the inlet measurement method shall be in accordance with Figure 2 and as follows.

- a) Install the FCU [see Figure 2, 1)] inside of the test chamber [see Figure 2, 8)].
- b) Use an auxiliary fan [see Figure 2, 7)] to maintain 0 Pa within the test chamber [see Figure 2, 8)].

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- c) Control the FCU external static pressure between the FCU discharge and adjustable duct resistance [see Figure 2, 5)] and measure within the FCU discharge ductwork [see Figure 2, 4)] (after connection spigots).
- d) Measure the airflow rate in the inlet duct [see Figure 2, 6)] to the auxiliary fan [see Figure 2, 7)].

**Figure 2 – Example of test installation (inlet measurement method)**



#### 4.7.6 Test procedure (inlet method)

**4.7.6.1** An auxiliary fan (see 4.3.5) shall be used to balance the inlet static pressure to the FCU to maintain 0 Pa within the test chamber (see Figure 2).

**4.7.6.2** The inlet section of the auxiliary fan shall be connected to an air flow measuring device in accordance with BS ISO 5801.

**4.7.6.3** All discharge connections of the FCU shall be connected to common ductwork, including a damper for adjusting the external static pressure (see Figure 2).

**4.7.6.4** External static pressure shall be recorded as an average across all discharge duct connections at a distance of no less than 500 mm from the FCU.

**4.7.6.5** The FCU shall be disconnected from the cooling or heating power supply or the liquid circulation shall be stopped.

**4.7.6.6** The adjustable duct resistance, e.g. damper (see Figure 2) shall be adjusted to achieve the mandatory or project-specific rating condition (external static pressure) in accordance with Table 1.

**4.7.6.7** With the FCU in operation, and once steady state conditions are achieved in accordance with Table 2, measurements in accordance with Table 3 shall be recorded.

*NOTE 1* For the measurement of static differential air pressure drop across the heat exchanger, see 4.9.

*NOTE 2* For information relating to variable air volume (VAV) operation, see Annex B.

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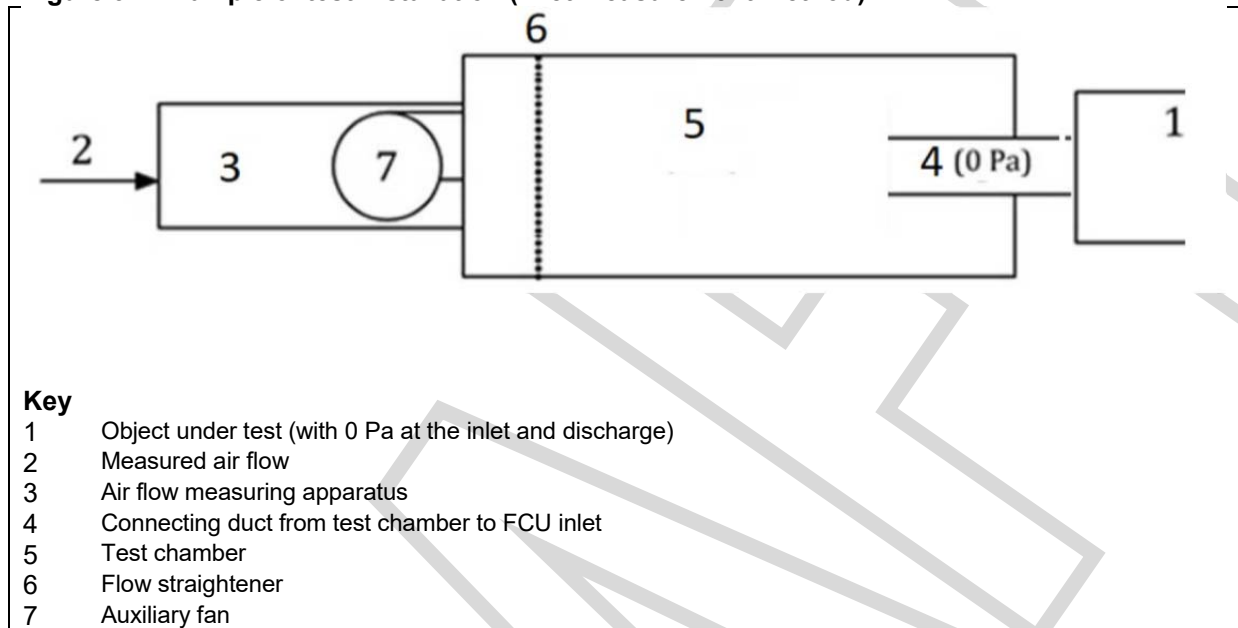
## 4.8 Non-ducted fan coil unit and cassette measurement test method

### 4.8.1 Inlet measurement Installation

Installation using the inlet measurement method shall be in accordance with Figure 3 and as follows.

- a) Install the FCU [see Figure 3 1)] outside the test chamber.
- b) Use an auxiliary fan [see Figure 3, 7)] to maintain 0 Pa within the inlet duct [see Figure 3, 4)].
- c) [see Figure 3, 4)]. Measure the airflow rate in the inlet duct to the auxiliary fan [see Figure 3, 3)]

**Figure 3 – Example of test installation (inlet measurement method)**



### 4.8.2 Test procedure (inlet method)

**4.8.2.1** An auxiliary fan shall be used to balance the inlet static pressure to the FCU to maintain 0 Pa within the inlet duct.

**4.8.2.2** The inlet section of the auxiliary fan shall be connected to an airflow measuring device in accordance with BS ISO 5801.

**4.8.2.3** The FCU shall be connected to the test chamber, by ductwork, including suitable transition to encapsulate the entire FCU inlet.

**4.8.2.4** The FCU shall be disconnected from the cooling or heating power supply or the liquid circulation shall be stopped.

**4.8.2.5** For each test, the auxiliary fan shall be adjusted to maintain 0 Pa within the inlet duct.

**4.8.2.6** With the FCU in operation, and once steady state conditions are achieved in accordance with Table 1, measurements in accordance with Table 3 shall be recorded.

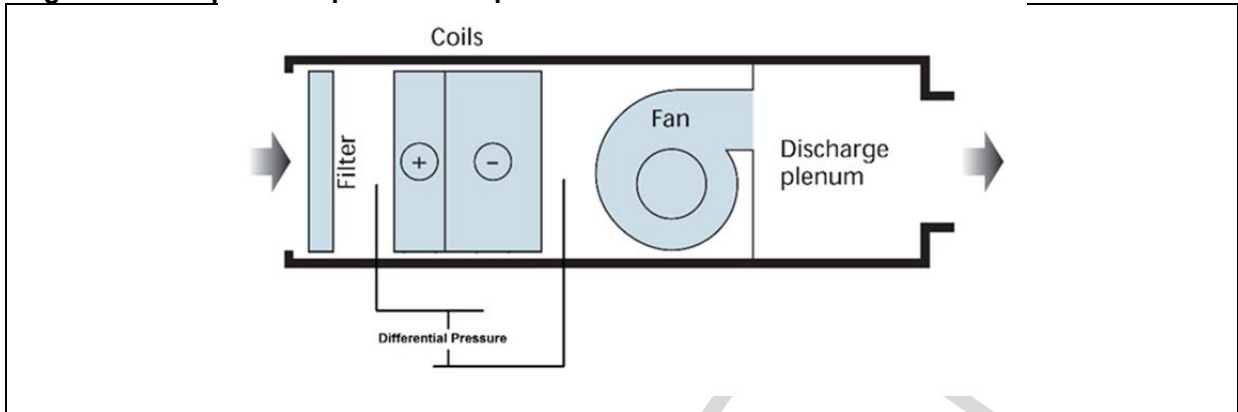
*NOTE* For the measurement of static differential air pressure drop across the heat exchanger, see 4.9.

## 4.9 Measurement of static differential air pressure drop across the heat exchanger

The setup for the measurement of the static differential air pressure drop across the heat exchanger shall be in accordance with Figure 4.

For each tested airflow, the static differential air pressure drop across the heat exchanger shall be recorded.

**Figure 4 – Setup for coil pressure drop measurement**



#### 4.10 Data to be recorded

The data to be recorded for each tested airflow shall be in accordance with Table 3.

*NOTE* The table identifies the minimum information required but is not intended to limit the data to be obtained.

#### 4.11 Calculation on measurement

##### 4.11.1 Correction of airflow rate according to ambient conditions

The measured airflow rate ( $q_{vtest}$ ) shall be corrected to standard conditions ( $q_{vref}$ ) in accordance with PD CEN/TS 17153.

Standard airflow rate conditions shall be:

$$p_{ref} = 101,325 \text{ kPa} \quad T_{ref} = 293.15 \text{ K}$$

##### 4.11.2 Calculation of specific fan power ( $P_{SFP}$ )

The specific fan power shall be calculated in accordance with BS EN 16798-3:2017, **9.5** as:

$$P_{sfp} = \frac{P_{elec}}{q_{vref}}$$

where:

$P_{sfp}$	is the specific fan power in W./l/s
$P_{elec}$	is the input power of the motor for the fan in W
$q_{vref}$	is the volume air flow rate through the fan in l/s corrected to standard conditions

## 5 Test report

### 5.1 Test results

Test results shall be recorded in a test report and include, as a minimum:

- type of configuration of the unit, (see Annex A);
- settings of the unit: wiring or control signal for fan speed setting, position of dampers and flaps, quantity, size and location of outlet connections, etc.;
- mandatory and/or project-specific rating conditions, and all relevant data in accordance with Table 3;
- corrected airflow rate for standard conditions (see **4.11.1**);
- calculation of specific fan power (see **4.11.2**);
- for mandatory conditions presented as variation of  $P_{sfp}$  with  $q_{vref}$  also, as appropriate, for project specific rating conditions; and



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g) results from tests with visual remarks.

*NOTE* For an example of a test report, see Annex C.

## **5.2 Additional information**

Test equipment calibration certificates shall be provided with the test report.

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## **Annex A (informative)**

### **Examples of the different types of configurations of fan coil units**

#### **A.1 General**

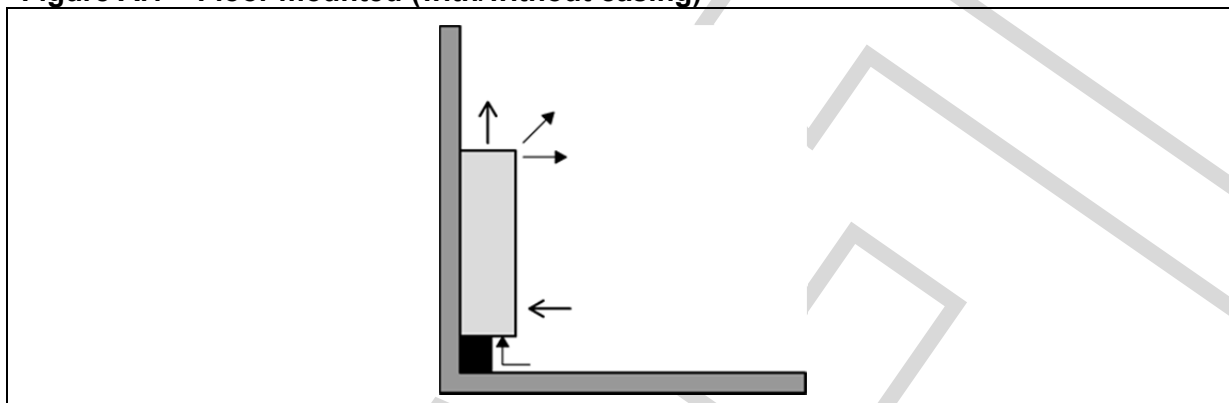
This annex provides drawing schemes associated with designations to show typical existing configurations of FCUs covered by this British Standard.

The list of described systems shown in A.2, Figure A.1 to A.9 and A.3, Figure is not exhaustive.

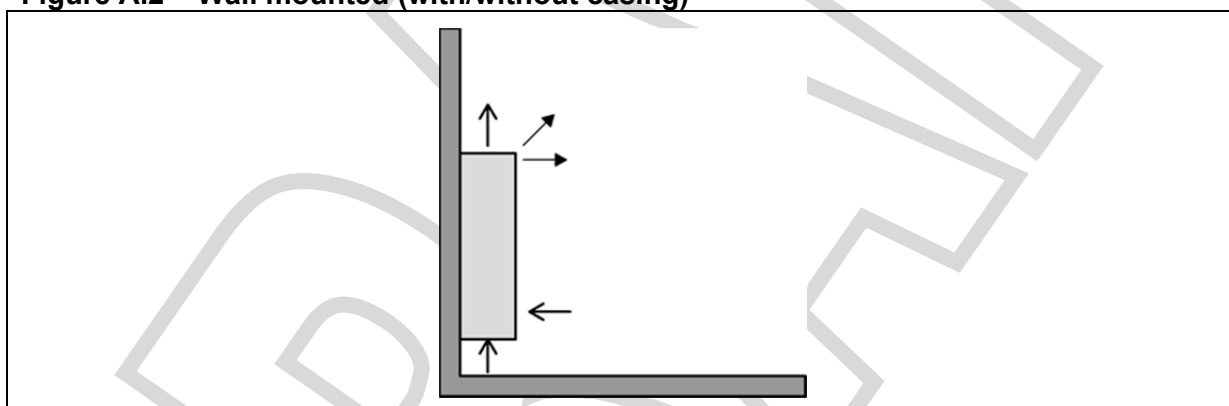
The air flows at inlet and outlet sections are represented by the arrows.

#### **A.2 Non ducted units**

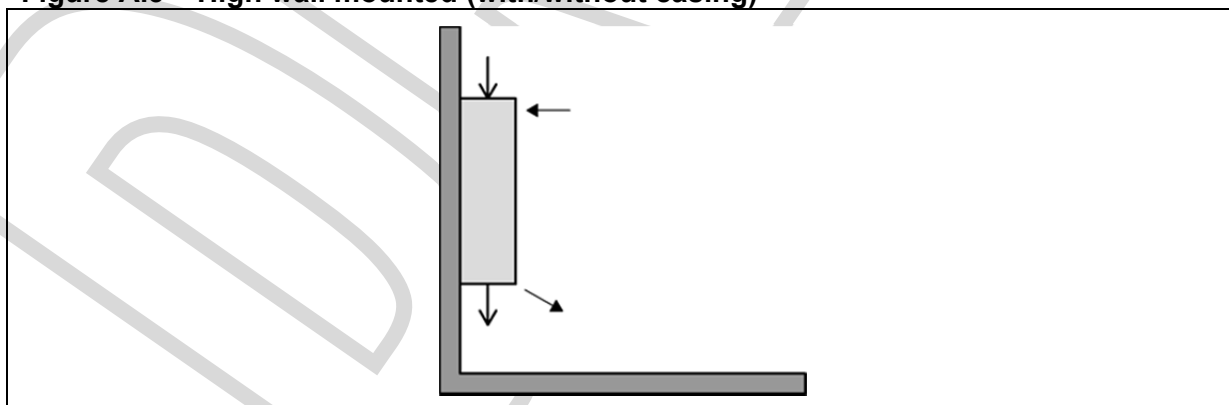
**Figure A.1 – Floor mounted (with/without casing)**



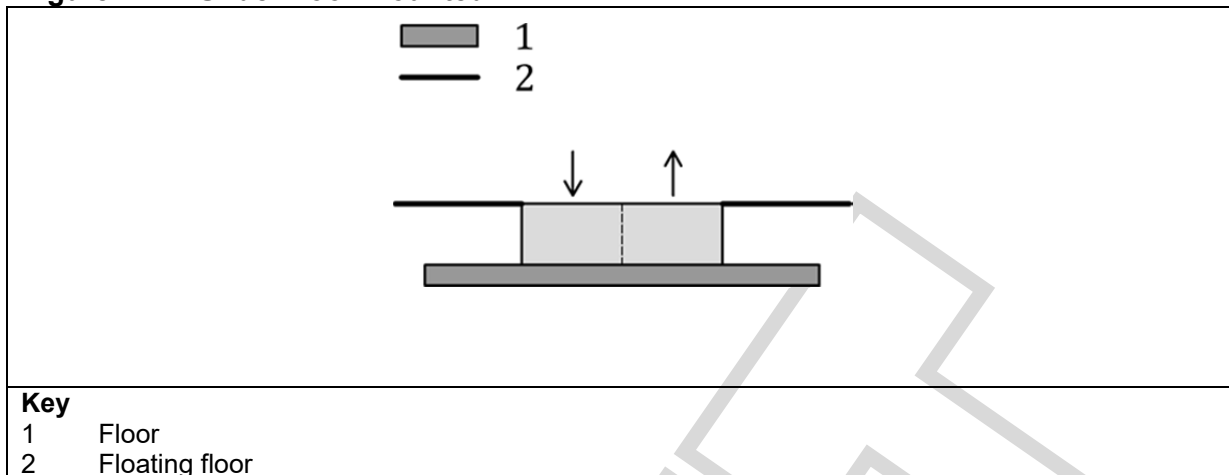
**Figure A.2 – Wall mounted (with/without casing)**



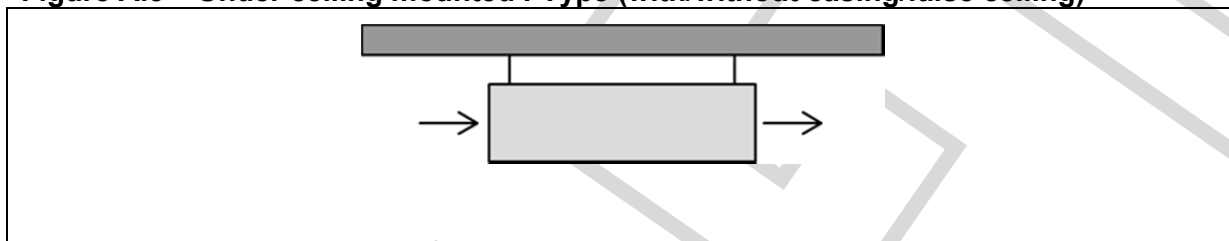
**Figure A.3 – High wall mounted (with/without casing)**



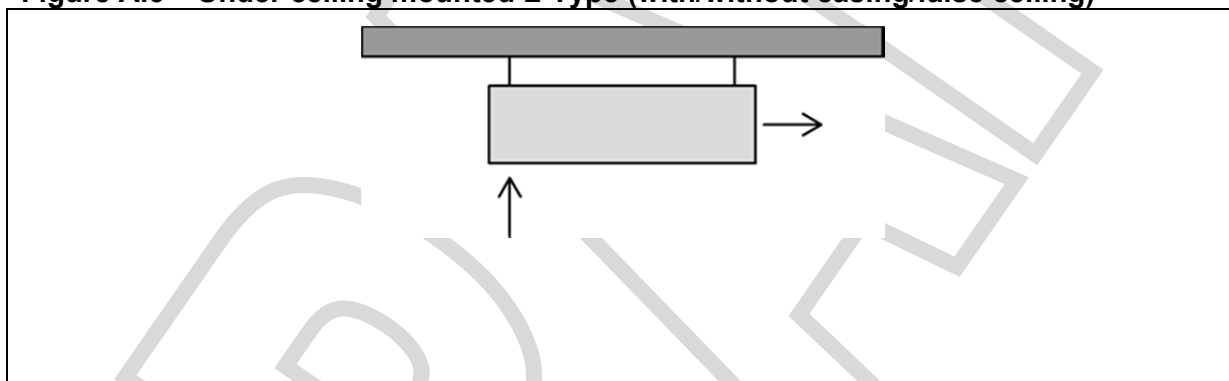
**Figure A.4 – Under floor mounted**



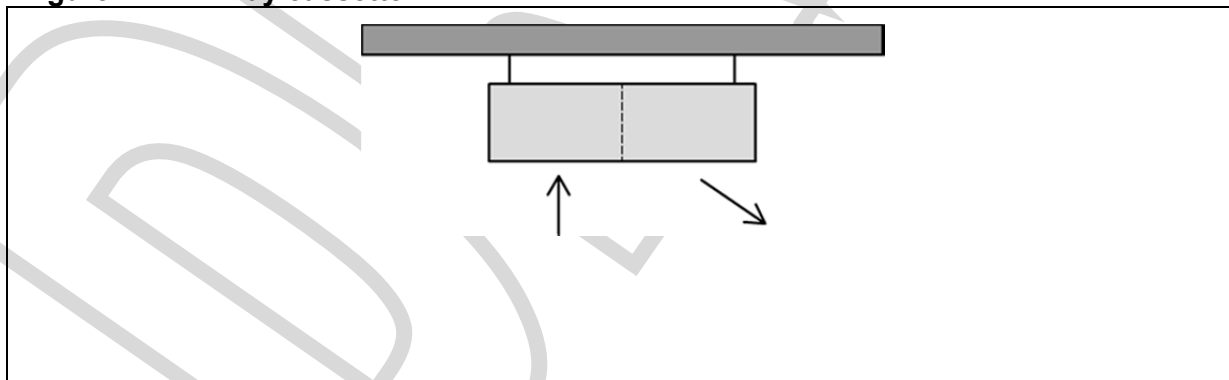
**Figure A.5 – Under ceiling mounted I-Type (with/without casing/false ceiling)**



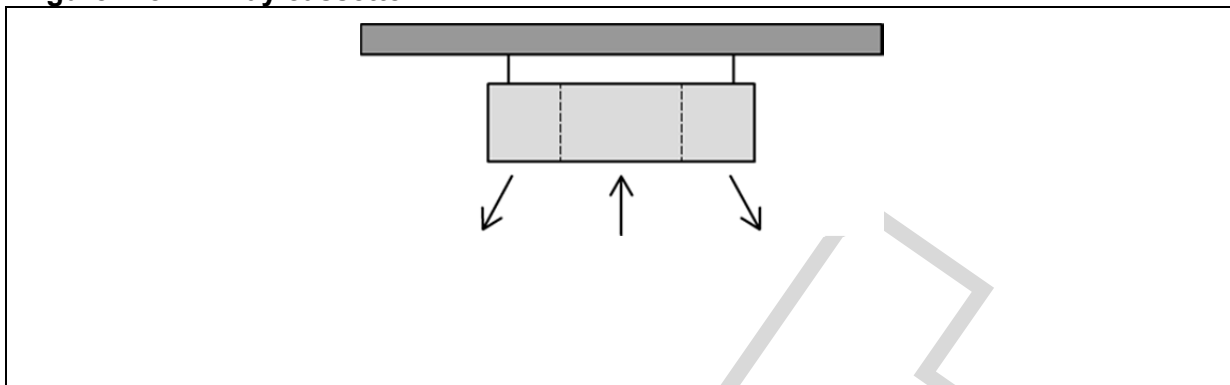
**Figure A.6 – Under ceiling mounted L-Type (with/without casing/false ceiling)**



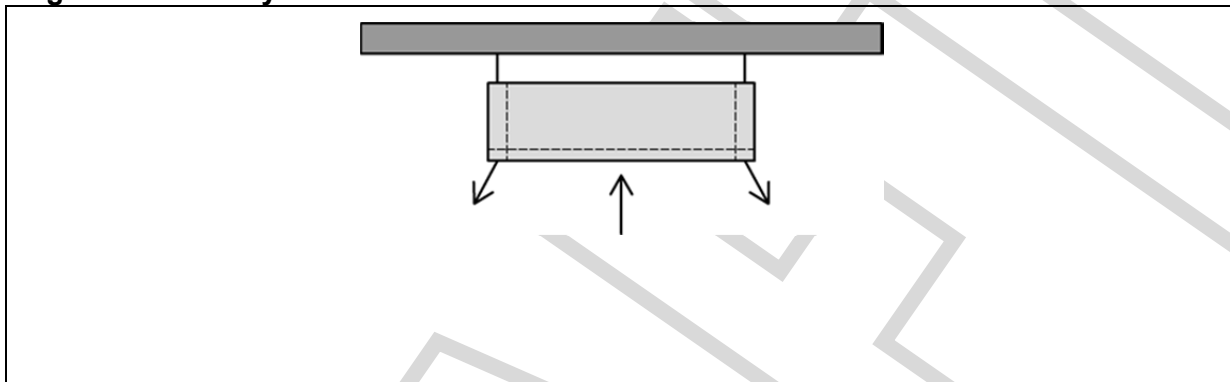
**Figure A.7 – 1-way cassette**



**Figure A.8 – 2-way cassette**



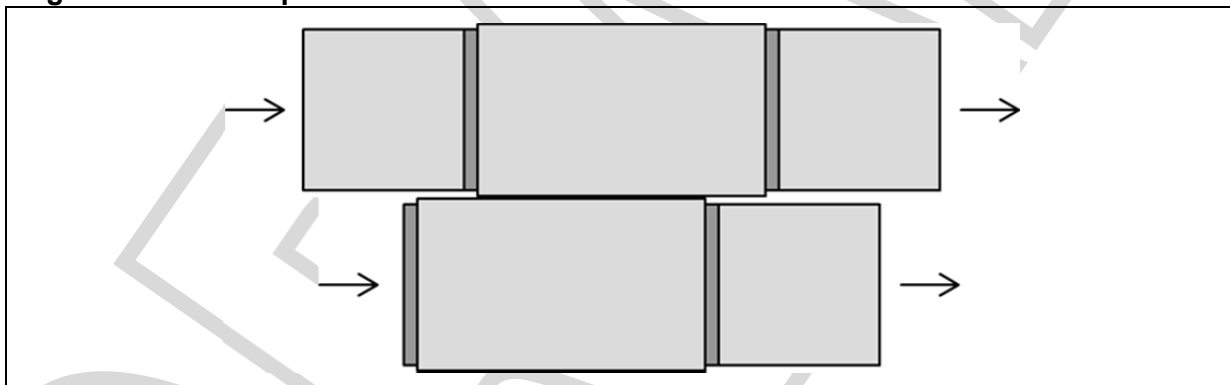
**Figure A.9 – 2-way cassette**



### **A.3 Ducted units**

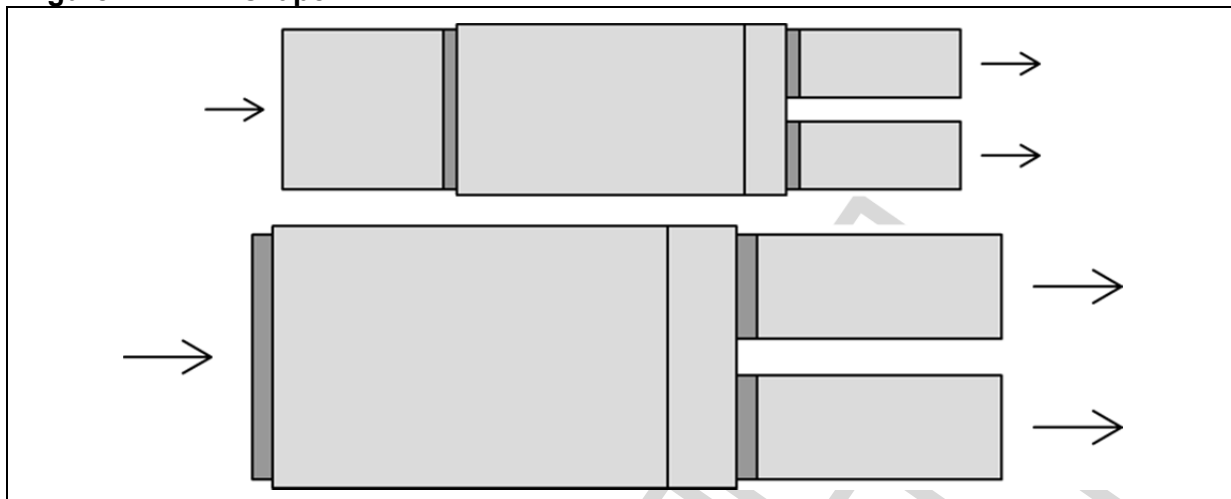
Examples of ducted units, on inlet and/or outlet sections, are given in Figures A.10 to A.13.

**Figure A.10 – I-shape**

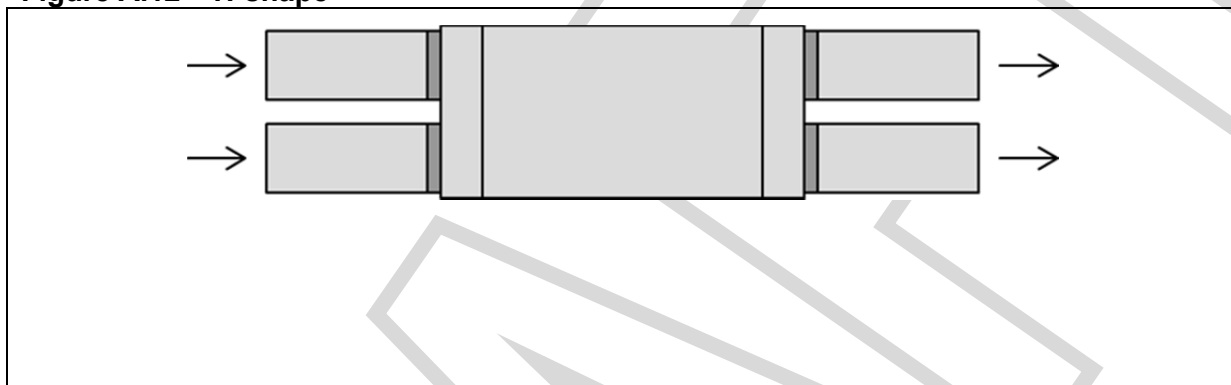


**WARNING.** THIS IS A DRAFT AND MUST NOT BE REGARDED OR USED AS A BRITISH STANDARD. THIS DRAFT IS NOT CURRENT BEYOND **15 JUNE 2020.**

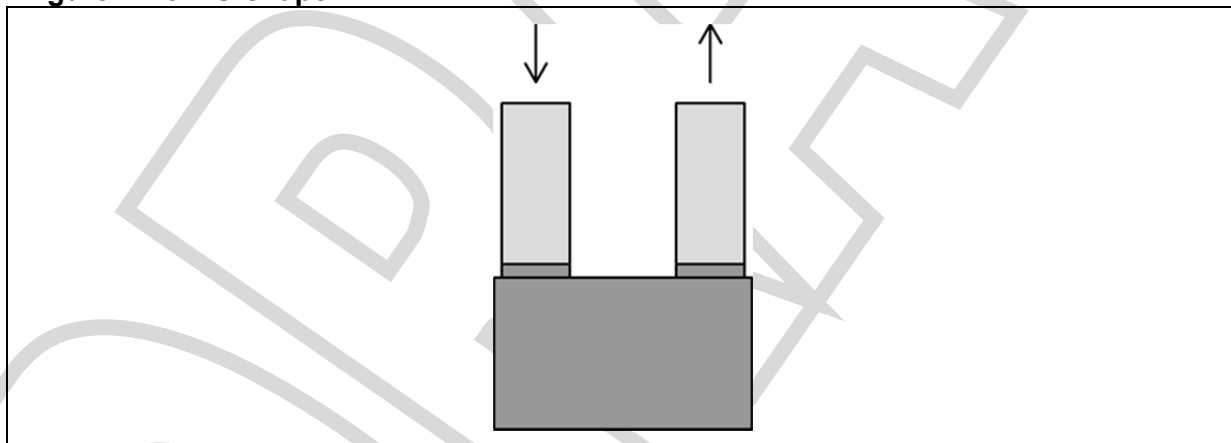
**Figure A.11 – Y-shape**



**Figure A.12 – H-shape**



**Figure A.13 – U-shape**



**Annex B (informative)**

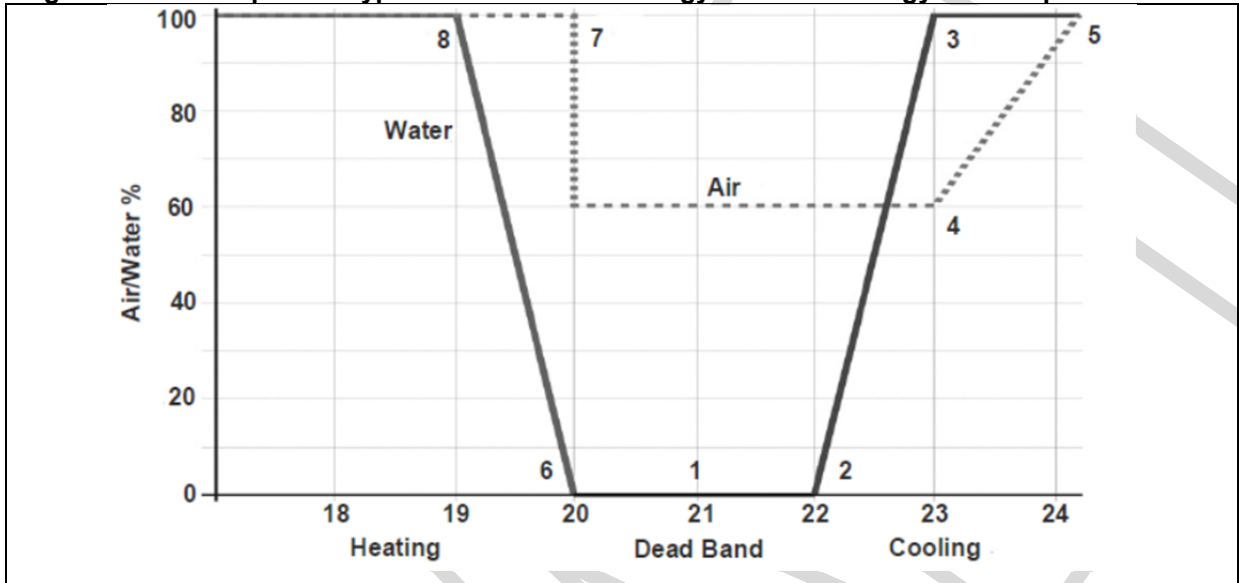
**Additional information for Variable Air Volume operation**

In FCUs, EC motors enable a form of variable air volume (VAV) control, where a BMS system, or similar, modulates the airflow rate, as well as water flow rate, between a present maximum and minimum air volume flow rate to meet the actual heating or cooling demand thus saving energy, reducing noise and increasing life expectancy.

*NOTE* See Figure B.1 for an example of a typical VAV fan coil strategy.

This lower airflow rate and associated reduction in external static pressure reduces the power consumption of the FCU and in consequence provides lower specific fan power ( $P_{SFP}$ ), reduced noise and increased life expectancy.

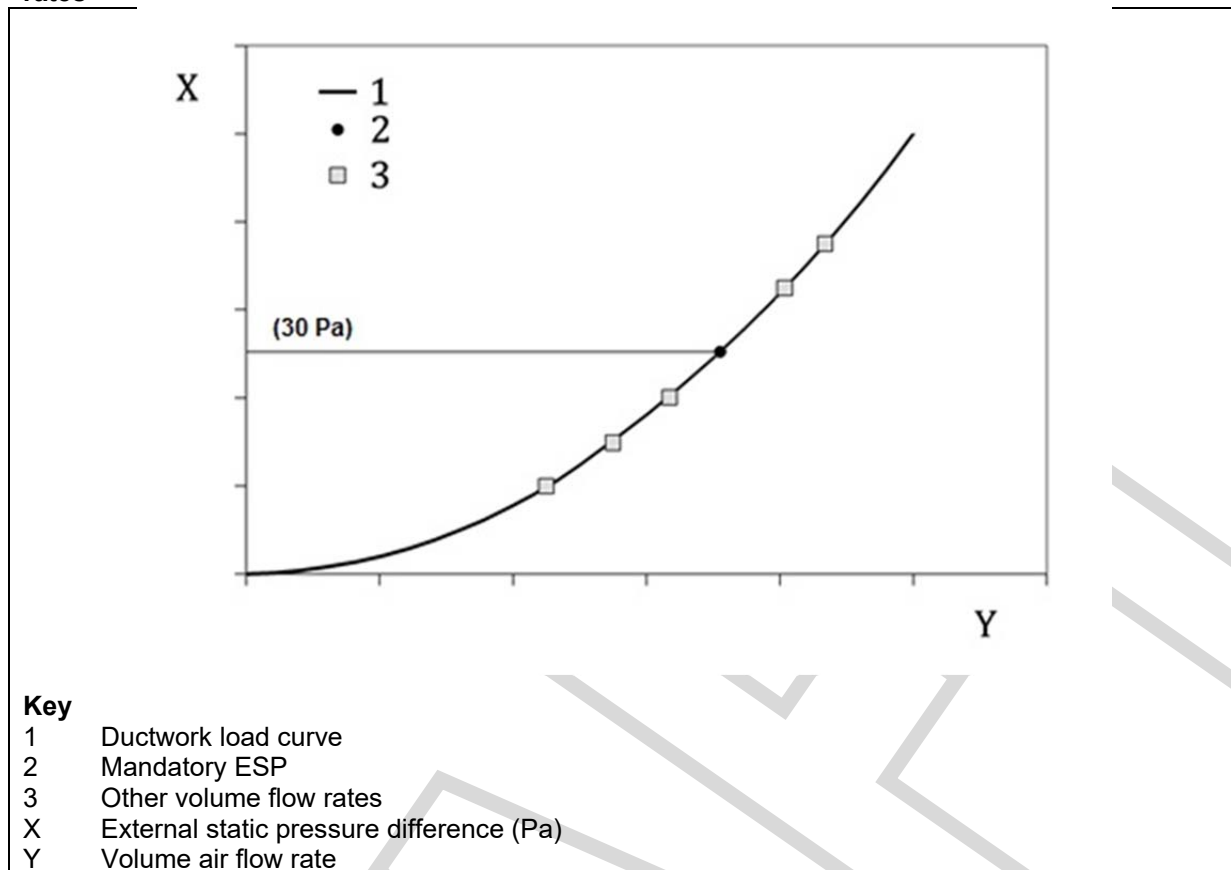
**Figure B.1 – Example of a typical VAV fan coil strategy to reduce energy consumption**



In order to demonstrate the improved energy efficiency of VAV fan coils and allow calculations to be performed on the annual energy consumption, additional air flow rate and corresponding motor input power measurements should be taken.

The data to be recorded for each test are given in Table 3 and a characteristic graph as Figure B.2 should be produced.

**Figure B.2 – Setup external static pressure difference of ducted units at other volume flow rates**



## Annex C (informative)

### Test report

Table C.1 provides an example of a test report.

**Table C.1 – Test report**

Test institute:	Test location:
Test supervisor:	Date:
Test object designation:	
Fan coil unit model:	Serial number:
Inlet filter class:	Outlet configuration (size/quantity):
Atmospheric pressure, kPa:	
Manufacturer:	
Tested to British Standard:	BS 8850:2020
Manufacturer comments:	

#### Results of measurements

	Symbol	Unit	Test 1	Test 2	Test 3
Test volume air flow rate, (measured)	$q_{vtest}$	l/s			
Corrected volume air flow rate, (corrected)	$q_{vref}$	l/s			
Voltage	—	V			
Frequency	—	Hz			
Speed control setting of the fan,	—	Vdc			
Total electric power absorbed	$P_{elec}$	W			
Air inlet dry bulb temperature	$t_A$	°C			
Air inlet wet bulb temperature	$t_{AW}$	°C			
External static pressure	$p_A$	Pa			
Static differential air pressure drop across the heat exchanger	$\Delta P_{coil}$	Pa			
Specific fan power	$P_{sfp}$	W.l/s			