
Specification for

Rating and testing unit air conditioners of above 7 kW cooling capacity

Spécification pour la classification et l'essai des éléments
de climatisation de capacité de refroidissement supérieure à 7 kW

Spezifikation für die Leistungsbestimmung und Prüfung von
Einheit-Klimaanlagen mit einer Kühlleistung über 7 kW

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Foreword

This British Standard is issued under the direction of the Refrigeration, Heating and Air Conditioning Standards Committee.

The methods of test for room air conditioners specified in BS 2852 are limited to those making use of room calorimeters. The present standard has therefore been prepared in order to specify psychrometric and other methods of test that are suitable for units of above 7 kW cooling capacity.

British Standard Specification for

Rating and testing unit air conditioners of above 7 kW cooling capacity

1. Scope

1.1 This British Standard specifies test conditions, and the corresponding test methods, for determining the performance characteristics of unit air conditioners of above 7 kW cooling capacity.

1.2 The standard also specifies the standard conditions on which the ratings are based and the test methods to be applied for determining the various ratings.

1.3 Air conditioners employing air cooled or water cooled condensers are within the scope of the standard.

1.4 The standard covers the use of air conditioners for cooling, but does not cover the performance of such air conditioners when used for heating or humidification.

2. References

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

3. Definitions

For the purposes of this British Standard the following definitions apply.

3.1 unit air conditioner. A complete system, factory made and tested, in a suitable frame or enclosure, that is fabricated and transported in one or more sections.

3.2 companion or block valves. Pairs of mating stopvalves, isolating sections of systems and so arranged that these sections may be joined before opening these valves or separated after closing them.

3.3 standard barometric pressure. Barometric pressure of 1.013 bar*.

3.4 reference air. Air having a density of 1.2 kg/m³.

3.5 wet bulb temperature. Temperature indicated when the temperature-sensing element and wetted wick have reached a state of constant temperature (evaporative equilibrium). (See 13.1.5.)

3.6 evaporator side discharge airflow of the unit. Rate of flow of air from the outlet(s) of the unit into the conditioned space.

3.7 evaporator side intake airflow of a unit. Rate of flow of air into the unit from the conditioned space.

3.8 outdoor discharge airflow of a unit. Rate of flow of air from the outdoor side outlet(s) of the unit.

3.9 outdoor intake airflow of a unit. Rate of flow of air into the unit through the outdoor side inlet(s) of the unit.

3.10 total evaporator side cooling effect of a unit. Total available capacity of the unit for removing sensible and

latent heat from the air passing through the evaporator side of the unit.

3.11 evaporator side dehumidifying effect (latent cooling effect). Total available capacity of the unit for removing latent heat from the air passing through the evaporator side of the unit.

3.12 evaporator side sensible cooling effect. Available capacity of the unit for removing sensible heat from the air passing through the evaporator side of the unit.

3.13 evaporator side sensible heat ratio. Ratio of the evaporator side sensible cooling effect to the evaporator side total cooling effect.

3.14 rated voltage(s). Voltage(s) shown on the nameplate of the unit.

3.15 rated frequency(ies) Frequency(ies) shown on the nameplate of the unit.

4. Test conditions

4.1 The methods specified in this standard are suitable for determining equipment cooling capacity at various test conditions that are specified in other standards.

4.2 In all cases, during the specified test period the test conditions shall be maintained within the tolerances specified in 14.5

5. Rating conditions

5.1 Cooling capacity rating conditions

5.1.1 The test conditions stated in table 1 (columns A, B and C) shall be considered standard rating conditions.

5.1.2 Units manufactured for use in a climate similar to that specified in table 1 (column A only) should have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type A units.

5.1.3 Units manufactured for use in a climate similar to that specified in table 1 (column B only) shall have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type B units.

5.1.4 Units manufactured for use in a climate similar to that specified in table 1 (column C only) shall have a nameplate rating determined by tests conducted at these specified conditions and shall be designated type C units.

5.1.5 Units manufactured for use in more than one of the types of climate specified in table 1 (columns A, B and C) shall have marked on the nameplate the designation, type and rating determined by test for each of the specified conditions for which they have been designed and tested.

* 1 bar = 10⁵ N/m² = 100 kPa.

Table 1. Cooling capacity test conditions

Test conditions	A	B	C
Room air temperature*; dry bulb wet bulb	27 °C 19 °C	29 °C 19 °C	21 °C 15 °C
Outside air temperature†: dry bulb wet bulb	35 °C 24 °C	46 °C 24 °C	27 °C 19 °C
Condenser water entering temperature and manufacturer's rated flow rates for A, B and C ratings	27 °C	27 °C	22 °C
Test frequency	Rated frequency‡		
Test voltage	Rated voltage§		

* Evaporator air inlet temperature

† Condenser air inlet temperature

‡ Units with dual rated frequencies should be tested at each frequency

§ Units with dual rated voltages should be tested in the higher voltage

Table 2. Maximum operating test conditions

Operating conditions	A	B	C
Room air temperature: dry bulb wet bulb	32 °C 23 °C	32 °C 23 °C	27 °C 19 °C
Outside air temperature: dry bulb wet bulb	43 °C 26 °C	52 °C 31 °C	35 °C 24 °C
Condenser water entering temperature	29 °C	34 °C	27 °C
Test frequency	Rated frequency*		
Test voltage (percentage of rated voltage)	(1) 90% and 110 % for units with a single nameplate rating (2) 95 % of minimum voltage and 110 % of maximum voltage for units with a dual nameplate voltage		

* Units with dual rated frequencies should be tested at each frequency.

5.1.6 Any capacity rating shall be followed by the corresponding voltage and frequency rating.

5.1.7 For a list of cooling capacity test methods see 6.1.

5.2 Maximum operating test conditions and test methods

5.2.1 Test conditions. The test conditions that shall apply during tests for maximum operating conditions are given in table 2. Tests shall be run at conditions in column A, column B or column C, based on intended use as determined in accordance with 5.1.

Units intended for use under more than one set of operating conditions shall have the highest relevant set of the intended operating conditions applied for test purposes.

5.2.2 Maximum operating conditions test. When operating at the test conditions specified in 5.2.1, units shall comply with the requirements of the maximum operating conditions. The unit's controls shall be set for maximum cooling and all ventilating air dampers and exhaust air dampers shall be closed.

5.2.2.1 Voltage adjustments. Test voltages shall be as specified in table 2. These voltages shall be maintained at the specified percentages under running conditions. The electrical service supplied to the unit service connection shall be such that the voltage will not rise more than 3 % when the unit is stopped. After the electrical service has been adjusted to accomplish this result, no subsequent adjustments shall be made during the tests.

5.2.2.2 Procedure. The unit shall be operated continuously for 2 h after the specified air temperatures and equilibrium condensate level have been established. All power to the unit shall then be cut off for 3 min and then restored for 1 h.

5.2.2.3 Requirements. During one entire test, the unit shall operate without visible or audible indication of damage.

The unit's motors shall operate continuously for the first 2 h of the test without tripping of the motor overload protective devices.

The motor overload protective device may trip only during the first 5 min after the shut-down period of 3 min. During the remainder of that 1 h test period, no motor overload protective device shall trip.

Units designed not to resume operation within the first 5 min after initial trip may remain out of operation for not longer than 30 min; they shall then operate continuously for 1 h.

5.3 Freeze-up test conditions and tests

5.3.1 Test conditions. The test conditions that shall apply during freeze-up tests for all models are given in table 3.

5.3.2 Freeze-up tests. When operating at the test conditions specified in table 3, units shall comply with the requirements of the freeze-up tests. The unit's controls, fan speeds, dampers and grilles shall be set to produce the maximum tendency to frost or ice the evaporator, provided such settings are not contrary to the manufacturer's operating instructions.

5.3.2.1 Air-blockage test

5.3.2.1.1 Procedure. The test shall be continuous, with the unit on the cooling cycle for 12 h after establishment of the specified temperature conditions.

Table 3. Freeze-up test conditions

Room air temperature: dry bulb wet bulb	21 °C* 16 °C
Outside air temperature: dry bulb wet bulb†	21 °C 16 °C
Condenser water temperature	22 °C
Test frequency	Rated frequency ‡
Test voltage	Rated voltage §

* 21 °C or the lowest temperature above 21 °C at which the regulating device will allow the unit to operate.

† The wet bulb temperature need not be controlled unless condensate is disposed of into the condenser airflow.

‡ Units with dual rated frequencies shall be tested at each frequency.

§ Units with dual rated voltages shall be tested at the higher voltage.

Table 4. Enclosure sweat test conditions

Room air temperature: dry bulb wet bulb	27 °C 24 °C
Outside air temperature: dry bulb wet bulb*	27 °C 24 °C
Condenser water temperature	27 °C
Test frequency	Rated frequency†
Test voltage	Rated voltage‡

* The wet bulb temperature need not be controlled unless condensate is disposed of into the condenser airflow.

† Units with dual rated frequencies shall be tested at each frequency.

‡ Units with dual rated voltages shall be tested at the higher voltage.

5.3.2.1.2 Requirements. At the end of 12 h any accumulation of ice or frost on the evaporator shall not completely obstruct the air passing through the evaporator coil.

5.3.2.2 Drip test

5.3.2.2.1 Procedure. The unit shall be operated for 6 h with the room-side air inlet partially blocking the passage of air, so as to attempt to achieve complete blockage of the evaporator coil by frost.

After the 6 h operating period, the unit shall be stopped and the air inlet covering removed until any accumulation of ice or frost has melted.

The unit shall then be turned on again, with the fans operating at the highest speed, for 5 min.

5.3.2.2.2 Requirements. During the test no ice shall drop from the units, and no water shall drip or blow off the unit on the room side.

5.4 Enclosure sweat test conditions and tests

5.4.1 Test conditions. The test conditions that shall apply during enclosure sweat tests for all models are given in table 4.

5.4.2 Enclosure sweat test. When operating at the test conditions specified in table 4, units shall comply with the requirements of the enclosure sweat tests. The unit's controls, fans, dampers and grilles shall be set to produce the maximum tendency to sweat, provided that such settings are not contrary to the manufacturer's operating instructions.

5.4.2.1 Procedure. After establishment of the specified temperature conditions, the unit shall be operated continuously for a period of 4 h.

5.4.2.2 Requirements. During the test, no condensed water shall drip, run or blow off the unit.

5.5 Condensate disposal test conditions and tests

5.5.1 Test conditions. Condensate disposal tests shall be carried out at the same conditions as those specified for enclosure sweat tests (see 5.4).

5.5.2 Condensate disposal test. When operating at the test conditions specified in 5.5.1 units shall comply with the requirements of the condensate disposal test conditions. The unit's controls, fans, dampers and grilles shall be set to produce the maximum tendency to sweat, provided such settings are not contrary to the manufacturer's operating instructions.

NOTE. This test may be carried out concurrently with the enclosure sweat test (see 5.4.2).

5.5.2.1 Procedure. After establishment of the specified temperature conditions, the unit shall be started with its condensate collection pan filled to the overflow point, and shall be operated continuously for 4 h after the condensate level has reached equilibrium.

5.5.2.2 Requirements. During this test the unit shall dispose of all condensate and there shall be no dripping or blowing-off of water from the unit; this requirement ensures that the building and surroundings do not become wet.

5.6 Airflow measuring conditions

5.6.1 Tests for determining airflow quantities for rating purposes shall be carried out at the conditions specified in table 1, with the refrigeration means in operation, and after condensate equilibrium has been obtained.

5.6.2 For airflow measurement see clause 11.

6. Test methods for cooling capacity

6.1 Standard test methods. The following six test methods for cooling capacity are in this standard:

- psychrometric method: evaporator side (see clause 7);
- psychrometric method: condenser side (see clause 7);
- psychrometric method: enclosure air-enthalpy (see 7.6.2);
- compressor calibration method (see clause 8);
- volatile refrigerant flow method (see clause 9);
- condenser water method (see clause 10).

6.2 Applicability of test methods

6.2.1 Unit air conditioners shall be tested using the method of condenser heat rejection specified in table 5, subject to any further limitations detailed in the test method parts of this standard.

6.2.2 Equipment having a total cooling capacity of less than 40 kW at the conditions of test shall be tested simultaneously by the evaporator side psychrometric method and one other specified method. The results of the tests by these two methods shall agree within the limits specified in 15.1.2.

6.2.3 Equipment having a total cooling capacity of 40 kW or more at the conditions of test shall be tested by at least one of the standard test methods listed in 6.1, but when the evaporator side psychrometric method is not employed the evaporator airflow rate and the latent cooling capacity shall be determined simultaneously, as specified in clauses 8 and 12.

6.2.4 Any of the test methods specified in this standard may be used to test unit air conditioners, but, in the capacity calculations, proper consideration is to be given to established energy balance principles.

Table 5. Test method applicability

Method of condenser heat rejection	Applicable test methods	
	(Less than 40 kW: see note 1 40 kW and above: see note 2)	
	Evaporator side	Condenser side
Air and evaporatively cooled	Psychro-metric	Psychrometric or compressor calibration
Water cooled	Psychro-metric	Condenser water or calibration (see note 3)

NOTE 1. The evaporator side psychrometric test method and one condenser side test method are required.

NOTE 2. When the evaporator side psychrometric method is not employed, condensate is to be measured and the evaporator airflow rate determined independently.

NOTE 3. Not applicable if the condenser is in an evaporator air stream.

7. Psychrometric methods

7.1 General description

7.1.1 In psychrometric methods cooling capacities are determined from measurements of the wet and dry bulb temperatures of the air entering and leaving the unit and from the associated airflow rate. These methods shall be employed for the evaporator side tests of all equipment having total cooling capacities of less than 40 kW and may be used for the evaporator side tests of equipment of

greater capacities. Subject to the additional requirements of 7.6 this method may be used for the condenser side tests of air and evaporatively cooled equipment rated at less than 40 kW except those employing remote liquid chillers. If the compressor is independently ventilated, condenser psychrometric tests are, additionally, subject to the apparatus arrangement limitations specified in 7.6.2.

7.1.2 The test apparatus arrangements described in 7.1.2.1 to 7.1.2.3 are recommended.

7.1.2.1 The open tunnel air-enthalpy psychrometric test method arrangement is shown in figure 1. The equipment to be tested is typically located in a test room or rooms (see clause 14). An air measuring device is attached to the equipment air discharge (evaporator or condenser, as applicable). This device discharges directly into the test room or space, which is provided with suitable means for maintaining the air entering the unit at the desired wet and dry bulb temperatures. Suitable means are provided for measuring the wet and dry bulb temperatures of the air entering and leaving the unit and for measuring the external resistance.

7.1.2.2 The closed tunnel air-enthalpy psychrometric test method arrangement is shown in figure 2. This arrangement differs from the open tunnel arrangement in that the air measuring device discharge is connected to suitable reconditioning equipment that is, in turn, connected to the equipment inlet. The resulting test 'loop' shall be sealed so that air leakage at places that would influence capacity measurements does not exceed 1.0 % of the test airflow rate. The dry bulb temperature of the air surrounding the equipment shall be maintained within $\pm 2.5^{\circ}\text{C}$ of the desired test inlet dry bulb temperatures. Suitable means are provided for measuring wet and dry bulb temperature and for measuring external resistance.

7.1.2.3 The enclosure air-enthalpy psychrometric test method arrangement is shown in figure 3. In this arrangement, an enclosure is placed over the equipment or applicable part of the equipment under test. This enclosure may be constructed of any suitable material, but should be essentially airtight and preferably insulated. It should be large enough to permit inlet air to circulate freely between the equipment and the enclosure, and in no case shall the enclosure be closer than 150 mm to any part of the equipment. The inlet to the enclosure should be remotely located from the equipment inlet, so as to cause circulation throughout the entire enclosed space. An air measuring device is connected to the equipment discharge. This device shall be well insulated where it passes through the enclosed space. Wet and dry bulb temperatures of the air entering the equipment inlet may be measured either at the equipment inlet or at the enclosure inlet. Suitable means are provided for measuring temperature and external resistance.

7.1.2.4 The arrangements shown in figures 1, 2 and 3 are intended to illustrate the various possibilities available, and should not be construed as applying specifically, or solely, to the types of equipment with which they are shown.

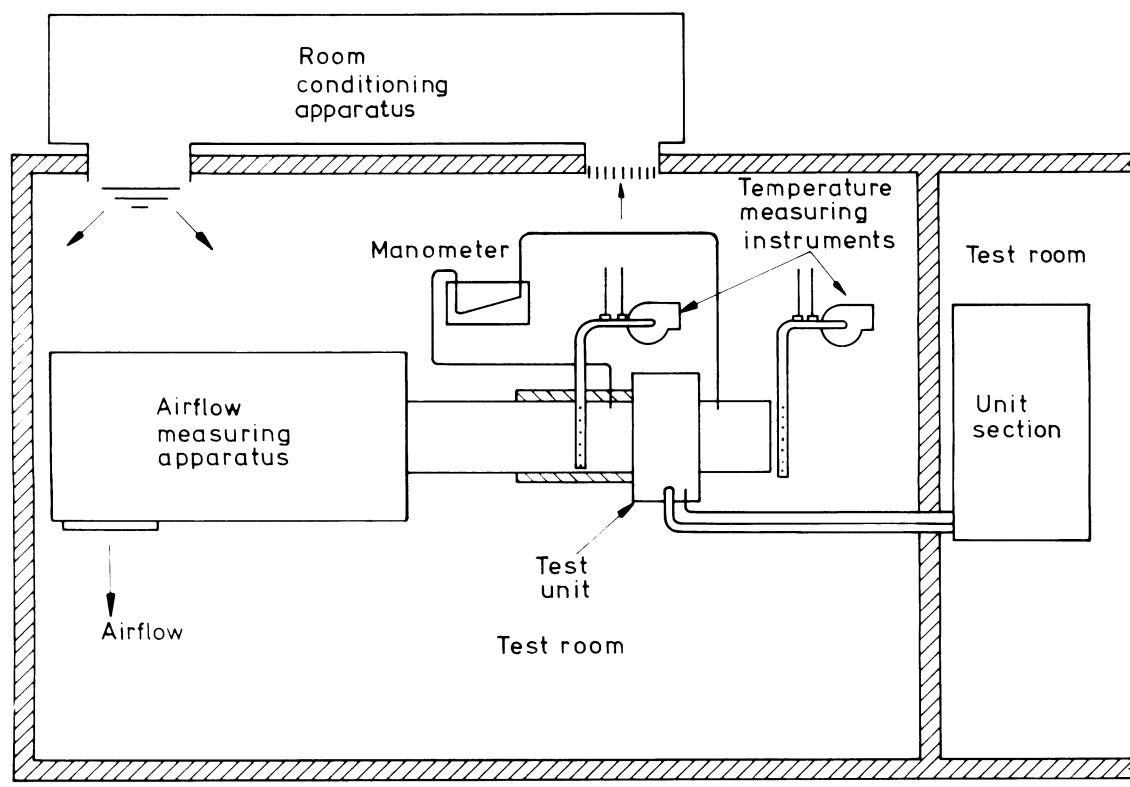


Figure 1. Open tunnel air-enthalpy psychrometric test method arrangement

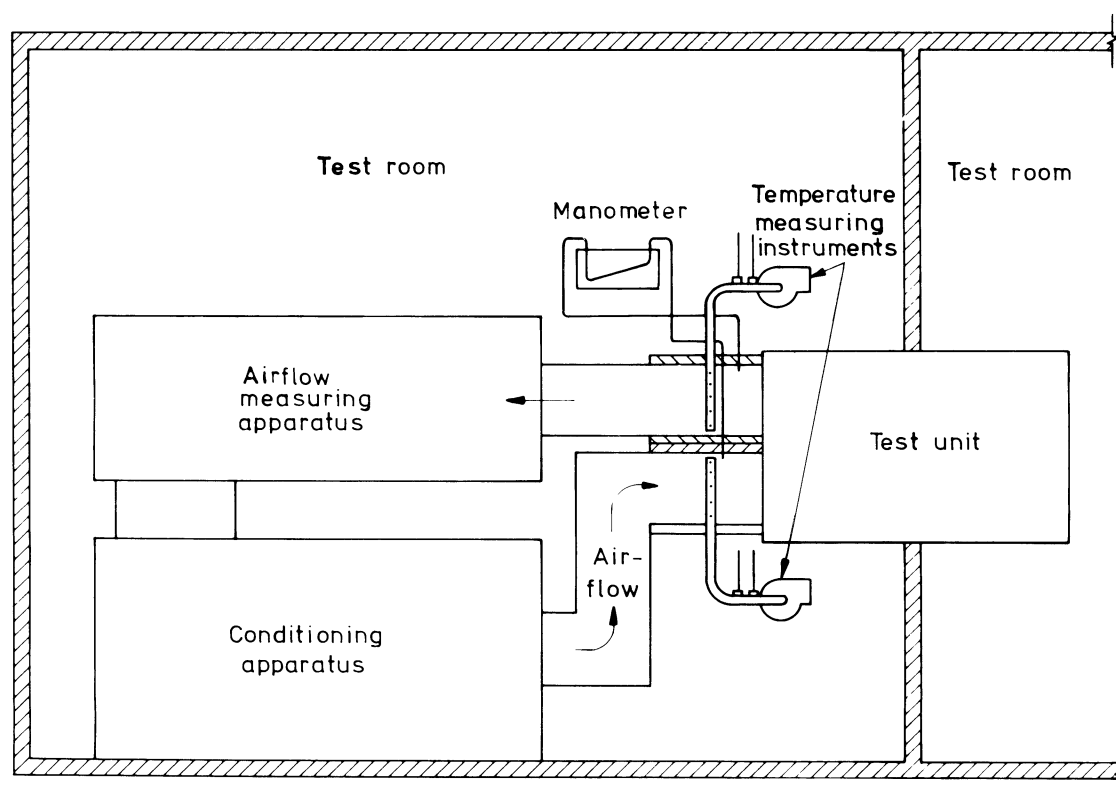


Figure 2. Closed tunnel air-enthalpy psychrometric test method arrangement