# INTERNATIONAL STANDARD

# ISO 13256-1

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## Water-source heat pumps — Testing and rating for performance —

## Part 1:
Water-to-air and brine-to-air heat pumps

*Pompes à chaleur à eau — Essais et détermination des caractéristiques de performance —*

*Partie 1: Pompes à chaleur eau-air et eau glycolée-air*

Reference number
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# Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

This part of ISO 13256 was developed by ISO Technical Committee TC 86, *Refrigeration,* Subcommittee SC 6, *Testing and rating of air-conditioners and heat pumps*.

ISO 13256 consists of the following parts, under the general title *Water-source heat pumps — Testing and rating for performance*:

— *Part 1: Water-to-air and brine-to-air heat pumps*

— *Part 2: Water-to-water and brine-to-water heat pumps*

Annexes A, B, C, D and E form an integral part of this part of ISO 13256. Annexes F, G and H are for information only.

# Introduction

This part of ISO 13256 covers heating and cooling systems which are generally referred to as "water-source heat pumps." These systems generally include an indoor coil with air-moving means, a compressor, and a refrigerant-to-water or refrigerant-to-brine heat exchanger. A system may provide both heating and cooling, cooling-only, or heating-only functions.

# Water-source heat pumps — Testing and rating for performance —

# Part 1:
Water-to-air and brine-to-air heat pumps

## 1 Scope

**1.1** This part of ISO 13256 establishes performance testing and rating criteria for factory-made residential, commercial and industrial, electrically-driven, mechanical-compression type, water-to-air and brine-to-air heat pumps. The requirements for testing and rating contained in this part of ISO 13256 are based on the use of matched assemblies.

**1.2** Equipment designed for rating at one application under this part of ISO 13256 may not be suitable at all applications covered in this part of ISO 13256.

**1.3** This part of ISO 13256 does not apply to the testing and rating of individual assemblies for separate use, nor to the testing and rating of heat pumps covered in ISO 5151, ISO 13253 or ISO 13256-2.

NOTE — For the purpose of the remaining clauses, the terms “equipment” or “heat pumps” may be used to mean “water-to-air heat pumps” or “brine-to-air heat pumps” and the term “liquid” refers to either “water” or “brine”.

## 2 Normative reference

The following standard contains provisions which, through reference in this text, constitute provisions of this part of ISO 13256. At the time of publication, the edition indicated was valid. All standards are subject to revision, and parties to agreements based on this part of ISO 13256 are encouraged to investigate the possibility of applying the most recent edition of the standard indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 817:—[1], *Refrigerants — Number designation*.

## 3 Definitions

For the purposes of this part of ISO 13256, the following definitions apply.

**3.1**
**water-to-air heat pump and/or brine-to-air heat pump**
heat pump which consists of one or more factory-made assemblies which normally include an indoor conditioning coil with air-moving means, compressor(s), and refrigerant-to-water or refrigerant-to-brine heat exchanger(s), including means to provide both cooling and heating, cooling-only, or heating-only functions

NOTES

1 When such equipment is provided in more than one assembly, the separated assemblies should be designed to be used together.

2 Such equipment may also provide functions of sanitary water heating, air cleaning, dehumidifying, and humidifying.

[1] To be published. (Revision of ISO 817:1974)

**3.1.1**
**water-loop heat pump application**
water-to-air heat pump using liquid circulating in a common piping loop functioning as a heat source/heat sink

NOTE — The temperature of the liquid loop is usually mechanically controlled within a temperature range of 15 °C to 40 °C.

**3.1.2**
**ground-water heat pump application**
water-to-air heat pump using water pumped from a well, lake or stream functioning as a heat source/heat sink

NOTE — The temperature of the water is related to the climatic conditions and may vary from 5 °C to 25 °C for deep wells.

**3.1.3**
**ground-loop heat pump application**
brine-to-air heat pump using a brine solution circulating through a subsurface piping loop functioning as a heat source/heat sink

NOTES

1 The heat exchange loop may be placed in horizontal trenches or vertical bores, or be submerged in a body of surface water.

2 The temprature of the brine is related to the climatic conditions and may vary from –5 °C to 40 °C.

**3.2**
**total cooling capacity**
amount of sensible and latent heat that the equipment can remove from the conditioned space in a defined interval of time, in watts, as determined by the specified test methods

**3.3**
**net total cooling capacity**
total cooling capacity with fan power adjustment

(See 4.1.3.)

**3.4**
**heating capacity**
amount of heat that the equipment can add to the conditioned space in a defined interval of time, in watts, as determined by the specified test methods

**3.5**
**net heating capacity**
heating capacity with fan power adjustment

(See 4.1.3.)

**3.6**
**rated voltage**
voltage shown on the nameplate of the equipment, in volts

**3.7**
**rated frequency**
frequency shown on the nameplate of the equipment, in hertz

**3.8**
**energy efficiency ratio (EER)**
ratio of the net total cooling capacity to the effective power input at any given set of rating conditions, in watts per watt

**3.9**
**coefficient of performance (COP)**
ratio of the net heating capacity to the effective power input of the equipment at any given set of rating conditions, in watts per watt

**3.10**
**standard air**
dry air at 20,0 °C and 101,324 kPa having a mass density of 1,204 $kg/m^3$

**3.11**
**effective power input**
average electrical power input to the equipment within a defined interval of time, in watts; i.e. the sum of:

— the power input for operation of the compressor excluding additional electrical heating devices,

— the power input of all control and safety devices of the equipment, and

— the proportional power input of the conveying devices for the transport of the heat transfer media through the heat pump only (e.g., fans, pumps, whether internal or external, whether provided with the equipment or not)

(See 4.1.3 and 4.1.4.)

**3.12**
**latent cooling capacity**
amount of latent heat that the equipment can remove from the conditioned space in a defined interval of time, in watts

**3.13**
**sensible cooling capacity**
amount of sensible heat that the equipment can remove from the conditioned space in a defined interval of time, in watts

# 4 Rating and test conditions

## 4.1 Rating conditions for the determination of capacity

### 4.1.1 Standard ratings

Standard ratings shall be established at the standard rating conditions specified in 4.2, using the test procedures described in clause 6. Standard ratings relating to cooling and heating capacities shall be net values, including the effects of circulating- fan heat, but not including supplementary heat. Standard efficiency ratings shall be based on the effective power input as defined in 3.11.

### 4.1.2 Power input of fans for heat pumps without duct connection

In the case of heat pumps which are not designed for duct connection and which are equipped with an integral fan, all power consumed by the fans shall be included in the effective power input to the heat pump.

### 4.1.3 Power input of fans for heat pumps with duct connection

**4.1.3.1** If no fan is provided with the heat pump, a fan power adjustment is to be included in the effective power input to the heat pump, using the following formula:

$$\phi_{fa} = \frac{q \times \Delta p}{\eta}$$

where

$\phi_{fa}$ is the fan power adjustment, in watts;

$\eta$ = 0,3 x $10^3$ by convention;

$\Delta p$ is the measured internal static pressure difference, in pascals;

$q$ is the nominal airflow rate, in litres per second.

This value shall be added to the heating capacity and subtracted from the cooling capacity.

**4.1.3.2** If a fan is an integral part of a heat pump, only the portion of the fan power required to overcome the internal resistance shall be included in the effective power input to the heat pump. The fraction which is to be excluded from the total power consumed by the fan shall be calculated using the following formula:

$$\phi_{\mathrm{fa}} = \frac{q \times \Delta p}{\eta}$$

where

$\phi_{fa}$ is the fan power adjustment, in watts;

$\eta$ = 0,3 x $10^3$ by convention;

$\Delta p$ is the measured external static pressure difference, in pascals;

$q$ is the nominal airflow rate, in litres per second.

This value shall be subtracted from the heating capacity and added to the cooling capacity.

### 4.1.4 Power input of liquid pumps

**4.1.4.1** If no liquid pump is provided with the heat pump, a pump power adjustment is to be included in the effective power consumed by the heat pump, using the following formula:

$$\phi_{\mathrm{pa}} = \frac{q \times \Delta p}{\eta}$$

where

$\phi_{pa}$ is the pump power adjustment, in watts;

$\eta$ = 0,3 x $10^3$ by convention;

$\Delta p$ is the measured internal static pressure difference, in pascals;

$q$ is the nominal fluid flow rate, in litres per second.

**4.1.4.2** If a liquid pump is an integral part of the heat pump, only the portion of the pump power required to overcome the internal resistance shall be included in the effective power input to the heat pump. The fraction which is to be excluded from the total power consumed by the pump shall be calculated using the following formula:

$$\phi_{\mathrm{pa}} = \frac{q \times \Delta p}{\eta}$$

where

$\phi_{pa}$ is the pump power adjustment, in watts;

$\eta$ = 0,3 x $10^3$ by convention;

$\Delta p$ is the measured external static pressure difference, in pascals;

$q$ is the nominal fluid flow rate, in litres per second.

### 4.1.5 Airflow rates

**4.1.5.1** All standard ratings shall be determined at airflow rates as described below. All airflow rates shall be expressed as litres per second of standard air as defined in 3.10.

**4.1.5.2** Ducted heat pumps which have integral fans shall be tested at the airflow rates specified by the manufacturer, or those obtained at zero external static pressure difference, whichever provides the lower airflow rate.

**4.1.5.3** Ducted heat pumps which do not have integral fans, but which are tested in combination with a device employing a fan, shall be tested as described in 4.1.5.2. Ducted heat pumps which do not have integral fans but which are rated for general use with a variety of air moving devices, shall be tested at the airflow rates specified by the manufacturer in the published ratings. However, the pressure drop across the indoor coil assembly and the recommended enclosures and attachment means shall not exceed 75 Pa.

**4.1.5.4** Non-ducted heat pumps shall be tested at the airflow rates obtained at zero external static pressure difference.

**4.1.5.5** The manufacturer shall specify a single airflow rate for all tests required in this part of ISO 13256 unless automatic adjustment of airflow rate is provided by the equipment. A separate control signal output for each step of airflow rate shall be considered as an automatic adjustement.

### 4.1.6 Liquid flow rates

**4.1.6.1** All standard ratings shall be determined at a liquid flow rate described below, expressed as litres per second.

**4.1.6.2** Heat pumps with integral liquid pumps shall be tested at the liquid flow rates specified by the manufacturer or those obtained at zero external static pressure difference, whichever provides the lower liquid flow rate.

**4.1.6.3** Heat pumps without integral liquid pumps shall be tested at the flow rates specified by the manufacturer.

**4.1.6.4** The manufacturer shall specify a single liquid flow rate for all of the tests required in this part of ISO 13256 unless automatic adjustment of the liquid flow rate is provided by the equipment. A separate control signal output for each step of liquid flow rate will be considered as an automatic adjustment.

### 4.1.7 Requirements for separated assemblies

In the case of heat pumps consisting of separate matched assemblies, the following installation procedures shall be followed.

a) Each refrigerant line shall be installed in accordance with the manufacturer’s instructions with the maximum stated length or 7,5 m, whichever is shorter. If the interconnecting tubing is furnished as an integral part of the equipment and not recommended for cutting the length, the equipment shall be tested with the complete length of tubing furnished.

b) The lines shall be installed without any significant difference in elevation (not more than 2 m).

### 4.1.8 Requirements for heat pumps with capacity control

**4.1.8.1** Part-load conditions shall be used for rating tests at levels or steps less than that of maximum capacity.

**4.1.8.2** Heat pumps with fixed steps of capacity control shall be rated at each step of capacity. Heat pumps with variable capacity control shall be rated at no less than two capacity levels, the minimum and the maximum capacities.

### 4.1.9 Test liquids

**4.1.9.1** The test liquid for water-loop heat pumps and ground water heat pumps shall be water.

**4.1.9.2** The test liquid for ground-loop heat pumps shall be a 15 % solution by mass of sodium chloride in water.

**4.1.9.3** The test liquid shall be sufficiently free of gas to ensure that the measured result is not influenced by the presence of gas.

## 4.2 Standard rating and part-load rating test conditions

**4.2.1** The test conditions for the determination of standard and part-load cooling ratings are specified in table 1.

**4.2.2** The test conditions for determination of standard and part-load heating ratings are specified in table 2.

**4.2.3** Heat pumps intended for a specific application shall be rated at the conditions specified for that application, for example, water-loop, ground-water, or ground-loop, and shall be identified as such (i.e. water-loop heat pump, ground-water heat pump, or ground-loop heat pump). Heat pumps intended for two or three applications shall be rated at the conditions specified for each of these applications and shall be so identified (see 7.3).

**4.2.4** For each test, the equipment shall be operated continuously until equilibrium conditions are attained, but for not less than one hour before capacity test data are recorded. The data shall then be recorded for 30 min at 5-min intervals until seven consecutive sets of readings have been attained within the tolerances specified in 6.4. The averages of these data shall be used for the calculation of the test results.

**Table 1 — Test conditions for the determination of cooling capacity**

| | **Water-loop heat pumps** | **Ground-water heat pumps** | **Ground-loop heat pumps** |
|---|---|---|---|
| Air entering indoor side<br>— dry bulb, °C<br>— wet bulb, °C | <br>27<br>19 | <br>27<br>19 | <br>27<br>19 |
| Air surrounding unit<br>— dry bulb °C | <br>27 | <br>27 | <br>27 |
| Standand rating test<br>Liquid entering heat exchanger, °C | <br>30 | <br>15 | <br>25 |
| Part-load rating test<br>Liquid entering heat exchanger,°C | <br>30 | <br>15 | <br>20 |
| Frequency* | Rated | Rated | Rated |
| Voltage** | Rated | Rated | Rated |

* Equipment with dual-rated frequencies shall be tested at each frequency.
** Equipment with dual-rated voltages shall be tested at both voltages or at the lower of the two voltages if only a single rating is published.

**Table 2 — Test conditions for the determination of heating capacity**

| | **Water-loop heat pumps** | **Ground-water heat pumps** | **Ground-loop heat pumps** |
|---|---|---|---|
| Air entering indoor side<br>— dry bulb, °C<br>— wet bulb, °C | <br>20<br>15 | <br>20<br>15 | <br>20<br>15 |
| Air surrounding unit<br>— dry bulb, °C | <br>20 | <br>20 | <br>20 |
| Standand rating test<br>Liquid entering heat exchanger, °C | <br>20 | <br>10 | <br>0 |
| Part-load rating test<br>Liquid entering heat exchanger, °C | <br>20 | <br>10 | <br>5 |
| Frequency* | Rated | Rated | Rated |
| Voltage** | Rated | Rated | Rated |

* Equipment with dual-rated frequencies shall be tested at each frequency.
** Equipment with dual-rated voltages shall be tested at both voltages or at the lower of the two voltages if only a single rating is published.

# 5 Performance requirements

## 5.1 General

**5.1.1** To comply with this part of ISO 13256, water-to-air and brine-to-air heat pumps shall be designed and produced such that any production unit will meet the applicable requirements of this part of ISO 13256.

**5.1.2** For heat pumps with capacity control, the performance requirements tests shall be conducted at maximum capacity.

## 5.2 Maximum operating conditions test

### 5.2.1 Test conditions

The maximum operating conditions tests shall be conducted for cooling and heating at the test conditions established for the specific applications (see 4.2.3) specified in tables 3 and 4. Heat pumps intended for use in two or more applications shall be tested at the most stringent set of conditions specified in tables 3 and 4.

**Table 3 — Maximum cooling test conditions**

| | **Water-loop heat pumps** | **Ground-water heat pumps** | **Ground-loop heat pumps** |
|---|---|---|---|
| Air entering indoor side*<br>— dry bulb, °C<br>— wet bulb, °C | <br>32<br>23 | <br>32<br>23 | <br>32<br>23 |
| Air surrounding unit<br>— dry bulb, °C | <br>32 | <br>32 | <br>32 |
| Liquid entering heat exchanger*, °C | 40 | 25 | 40 |
| Frequency** | Rated | Rated | Rated |
| Voltage | 1) 90 % and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. | 1) 90 % and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. | 1) 90% and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. |

* Air and liquid flow rates shall be as established in 4.1.5 and 4.1.6.
** Equipment with dual-rated frequencies shall be tested at each frequency.

**Table 4 — Maximum heating test conditions**

| | **Water-loop heat pumps** | **Ground-water heat pumps** | **Ground-loop heat pumps** |
|---|---|---|---|
| Air entering indoor side*<br>— dry bulb, °C | <br>27 | <br>27 | <br>27 |
| Air surrounding unit<br>— dry bulb, °C | <br>27 | <br>27 | <br>27 |
| Liquid entering heat exchanger*, °C | 30 | 25 | 25 |
| Frequency** | Rated | Rated | Rated |
| Voltage | 1) 90 % and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. | 1) 90 % and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. | 1) 90 % and 110 % of rated voltage for equipment with a single nameplate rating.<br>2) 90 % of minimum voltage and 110 % of maximum voltage for equipment with dual nameplate voltage. |

* Air and liquid flow rates shall be as established in 4.1.5 and 4.1.6.
** Equipment with dual-rated frequencies shall be tested at each frequency.

#### 5.2.2 Test procedures

**5.2.2.1** The equipment shall be operated continuously for one hour after the specified temperatures have been established at each specified voltage level.

**5.2.2.2** The 110 % voltage test shall be conducted prior to the 90 % voltage test.

**5.2.2.3** All power to the equipment shall be cut off for 3 min at the conclusion of the one hour test at the 90 % voltage level and then restored for one hour.

#### 5.2.3 Test requirements

Heat pumps shall meet the following requirements when operating at the conditions specified in tables 3 and 4.

**5.2.3.1** During the entire test, the equipment shall operate without any indication of damage.

**5.2.3.2** During the test period specified in 5.2.2.1, the equipment shall operate continuously without tripping any motor overload or other protective devices.

**5.2.3.3** During the test period specified in 5.2.2.3, the motor overload protective device may trip only during the first 5 min of operation after the shutdown period of 3 min. During the remainder of the test period, no motor overload protective device shall trip. For those models so designed that resumption of operation does not occur within the first 5 min after the initial trip, the equipment may remain out of operation for no longer than 30 min. It shall then operate continuously for the remainder of the test period.

### 5.3 Minimum operating conditions test

#### 5.3.1 Test conditions

Heat pumps shall be tested at the minimum operating test conditions for cooling and heating at the test conditions established for the specific applications (see 4.2.3) specified in tables 5 and 6. Heat pumps intended for use in two or more applications shall be tested at the most stringent set of conditions specified in tables 5 and 6.

#### 5.3.2 Test procedures

For the minimum operating cooling test, the heat pump shall be operated continuously for a period of no less than 30 min after the specified temperature conditions have been established. For the minimum operating heating test, the heat pump shall soak for 10 min with liquid at the specified temperature circulating through the coil. The equipment shall then be started and operated continuously for 30 min.

#### 5.3.3 Test requirements

No protective device shall trip during these tests and no damage shall occur to the equipment.

### 5.4 Enclosure sweat and condensate test

#### 5.4.1 Test conditions

The enclosure sweat and condensate test shall be conducted in the cooling mode at the test conditions established for the specific applications specified in table 7.

All 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 instructions to the user. Heat pumps intended for two or more applications shall be tested at the most stringent set of conditions.

#### 5.4.2 Test procedures

After establishment of the specified temperature conditions, the heat pump shall be operated continuously for a period of four hours.

#### 5.4.3 Test requirements

No condensed water shall drip, run or blow off the equipment's casing during the test.

**Table 5 — Minimum cooling test conditions**

| | Water-loop heat pumps | Ground-water heat pumps | Ground-loop heat pumps |
|---|---|---|---|
| Air entering indoor side*<br>— dry bulb, °C<br>— maximum wet bulb, °C | <br>21<br>15 | <br>21<br>15 | <br>21<br>15 |
| Air surrounding unit<br>— dry bulb, °C | <br>21 | <br>21 | <br>21 |
| Liquid entering heat exchanger*, °C | 20 | 10 | 10 |
| Frequency** | Rated | Rated | Rated |
| Voltage*** | Rated | Rated | Rated |

* Air and liquid flow rates shall be as established in 4.1.5 and 4.1.6.
** Equipment with dual-rated frequencies shall be tested at each frequency.
*** Equipment with dual-rated voltages shall be tested at the lower of the two voltages.

**Table 6 — Minimum heating test conditions**

| | Water-loop heat pumps | Ground-water heat pumps | Ground-loop heat pumps |
|---|---|---|---|
| Air entering indoor side*<br>— dry bulb, °C | <br>15 | <br>15 | <br>15 |
| Air surrounding unit<br>— dry bulb, °C | <br>15 | <br>15 | <br>15 |
| Liquid entering heat exchanger*, °C | 15 | 5 | –5 |
| Frequency** | Rated | Rated | Rated |
| Voltage*** | Rated | Rated | Rated |

* Air and liquid flow rates shall be as established in 4.1.5 and 4.1.6.
** Equipment with dual-rated frequencies shall be tested at each frequency.
*** Equipment with dual-rated voltages shall be tested at the lower of the two voltages.

**Table 7 — Enclosure sweat and condensate test conditions**

| | Water-loop heat pumps | Ground-water heat pumps | Ground-loop heat pumps |
|---|---|---|---|
| Air entering indoor side*<br>— dry bulb, °C<br>— wet bulb, °C | <br>27<br>24 | <br>27<br>24 | <br>27<br>24 |
| Air surrounding unit<br>— dry bulb, °C | <br>27 | <br>27 | <br>27 |
| Liquid entering heat exchanger*, °C | 20 | 10 | 10 |
| Frequency** | Rated | Rated | Rated |
| Voltage*** | Rated | Rated | Rated |

* Air and liquid flow rates shall be as established in 4.1.5 and 4.1.6.
** Equipment with dual-rated frequencies shall be tested at each frequency.
*** Equipment with dual-rated voltages shall be tested at the lower of the two voltages.

# 6 Test methods

## 6.1 General

The standard capacity ratings shall be determined by the test methods and procedures established in this clause and annex A. The total cooling and heating capacities shall be the average of the results obtained using the liquid enthalpy test method (annex C) and the indoor air enthalpy test method (annex B), or optionally, for non-ducted equipment, the calorimeter room test method (annex E). The results obtained by these two methods must agree within 5 % in order for a particular test to be valid. Measurements shall be made in accordance with the provisions of annexes D and F.

## 6.2 Uncertainties of measurement

The uncertainties of measurement shall not exceed the values specified in table 8.

**Table 8 — Uncertainties of measurement for indicated values**

| Measured quantity | Unit | Uncertainty of measurement [1] |
|---|---|---|
| Water<br>— temperature<br>— temperature difference<br>— volume flow<br>— static pressure difference | <br>° C<br>° C<br>l/s<br>Pa | <br>±0,1 °C<br>±0,1 °C<br>±1 %<br>±5 Pa ($p \leqslant$ 100 Pa)<br>±5 % ($p >$ 100 Pa) |
| Air<br>— dry bulb temperature<br>— wet bulb temperature<br>— volume flow<br>— static pressure difference | <br>° C<br>° C<br>l/s<br>Pa | <br>±0,2 °C<br>±0,2 °C<br>±5%<br>±5 Pa ($p \leqslant$ 100 Pa)<br>±5 % ($p >$ 100 Pa) |
| | Electrical inputs | 0,5 % |
| | Time | 0,2 % |
| | Mass | 1,0 % |
| | Speed | 1,0 % |

[1] Uncertainty of measurement: an estimate characterizing the range of values within which the true value of a measurand lies (measurand: a quantity subject to measurement).

NOTE — Uncertainty of measurement comprises, in general, many components. Some of these components may be estimated on the basis of the statistical distribution of the results of a series of measurements and can be charagcterized by experimental standard deviations. Estimates of other components can be based on experience or other information.

## 6.3 Data to be recorded

The data to be recorded during the test include the following.

— Date
— Observer(s)
— Barometric pressure, in kilopascals
— Equipment nameplate data
— Time data was recorded
— Total power input to equipment, in watts
— Applied voltage(s), in volts
— Frequency, in hertz
— External static pressure difference, air (for units with integral fans), in pascals
— Internal static pressure difference, air (for units without integral fans), in pascals
— Fan speed(s), (if adjustable), in r/min
— Dry-bulb temperature of air entering equipment, in degrees Celsius
— Wet-bulb temperature of air entering equipment, in degrees Celsius
— Dry-bulb temperature of air leaving equipment, in degrees Celsius

— Wet-bulb temperature[2)] of air leaving equipment, in degrees Celsius
— Volume flow rate of air and all relevant measurements for its calculations, in litres per second
— Temperature of liquid entering heat exchanger, in degrees Celsius
— Temperature of liquid leaving heat exchanger, in degrees Celsius
— Liquid flow rate, in litres per second
— External static pressure difference, liquid (for units with integral pumps), in pascals
— Internal static pressure difference, liquid (for units without integral pumps), in pascals

## 6.4 Test tolerances

**6.4.1** The maximum permissible variation of any observation during the capacity test is listed in the first column of table 9. The maximum permissible variation of any observation during the performance tests is listed in table 10.

**6.4.2** The maximum permissible variations of the average of the test observations from the standard or desired test conditions are shown in the second column of table 9.

**Table 9 — Variations allowed in capacity test readings**

| Readings | Maximum variation of individual reading from rating conditions | Variations of arithmetical average values from specified test conditions |
|---|---|---|
| Indoor air inlet temperature<br>— dry bulb<br>— wet bulb | <br>±1,0 °C<br>±0,5 °C | <br>±0,3 °C<br>±0,2 °C |
| Air volume flow rate | ±10 % | ±5 % |
| Voltage | ±2 % | ±1 % |
| Liquid temperature<br>— inlet | <br>±0,5 °C | <br>±0,2 °C |
| Liquid volume flow rate | ±2 % | ±1 % |
| External resistance to airflow, Pa | ±10 % | ±5 % |

**Table 10 — Variations allowed in performance test readings**

| Quantity measured | Maximum variation of individual readings from stated performance test conditions |
|---|---|
| For minimum operating conditions test:<br>— air temperatures<br>— liquid temperatures | <br>+1 °C<br>+0,6 °C |
| For maximum operating conditions tests:<br>— air temperatures<br>— liquid temperatures | <br>–1 °C<br>–0,6 °C |
| For other tests:<br>— air temperatures<br>— liquid temperatures | <br>±1 °C<br>±0,6 °C |

## 6.5 Test results

The results of a capacity test shall express quantitatively the effects produced upon the air by the equipment tested. For given test conditions, the capacity test results shall include such of the following quantities as are applicable:

a) total cooling capacity (see 6.1), in watts

b) heating capacity (see 6.1), in watts

c) measured power input to equipment, in watts

[2)] Required only for cooling capacity tests.

d) fan power adjustment (see 4.1.3), in watts

e) liquid pump power adjustment (see 4.1.4), in watts

f) effective power input to equipment or power inputs to all equipment, in watts

g) net total cooling capacity (see 4.1.3), in watts

h) net heating capacity (see 4.1.3), in watts

i) energy efficiency ratio (see 3.8), in watts per watt

j) coefficient of performance (see 3.9), watts per watt

# 7 Marking provisions

## 7.1 Nameplate requirements

Each water-to-air and brine-to-air heat pump, whether composed of a single package or separate assemblies, shall have a durable nameplate, firmly attached to each separate assembly in a location accessible for reading.

## 7.2 Nameplate information

The nameplate shall provide the following minimum information in addition to the information required in international safety standards.

a) Manufacturer's name or trademark[3].

b) Distinctive type or model designation and serial number.

c) Full-load capacity rating (see 7.3). Equipment rated for more than one application shall state capacity ratings for both heating and cooling, as appropriate, for each application.

d) Rated voltage(s).

e) Rated frequency(ies).

f) Refrigerant designation and refrigerant mass charge (see 7.4).

## 7.3 Designation of capacity ratings

The designation of capacity rating shall be established in such a way that the heat transfer media are indicated (A = air, W = water, and B = brine), together with their temperatures, followed by their capacities in kilowatts. The capacities shall be stated to the nearest kilowatt. The figure following the first "W" shall be the liquid temperature of the water-loop heat pump; the figure following the second "W" shall be the liquid temperature of the ground-water heat pump; the figure following the "B" shall be the liquid temperature of the ground-loop heat pump.

| | | | |
|---|---|---|---|
| EXAMPLE: | Cooling: | A27 - W30/W15/B25 | 10/12/11 kW |
| | Heating: | A20 - W20/W10/B0 | 10/9/8 kW |

## 7.4 Refrigerant designation

The refrigerant designation shall be in accordance with ISO 817.

[3] The manufacturer is considered to be the firm identified on the nameplate.

# 8 Publication of ratings

## 8.1 Standard ratings

**8.1.1** Standard ratings shall be published for the net heating capacity, the net total cooling capacity, part-load ratings (where applicable), energy efficiency ratio and coefficient of performance, as appropriate, for each heat pump produced in conformance with this part of ISO 13256 for each intended application. These ratings shall be based on data obtained at the established rating conditions in accordance with the testing procedures specified in this part of ISO 13256.

**8.1.2** The values of the standard capacities shall be expressed in kilowatts, rounded to three significant figures.

**8.1.3** The values of energy efficiency ratios and coefficients of performance shall be rounded to the nearest 0,05.

**8.1.4** Each capacity rating shall be followed by the corresponding voltage and frequency ratings.

**8.1.5** Standard ratings are representative of equipment operating at zero external static pressure for both air and liquid flows. Additional calculations using the methods specified in this part of ISO 13256 may be needed to derive performance of specific applications.

## 8.2 Application ratings

Additional ratings may be published based on conditions other than those specified as standard rating conditions if they are clearly specified and the data are determined by the methods specified in this part of ISO 13256, or by analytical methods which are verifiable by the test methods prescribed in clause 6, and are accompanied by the standard net capacity ratings, energy efficiency ratios, and the coefficients of performance.

# Annex A
(normative)

# Test procedures

## A.1 General test room requirements

**A.1.1** The indoor condition test room shall be a room or space in which the desired test conditions can be maintained within the prescribed tolerances.

**A.1.2** It is recommended that air velocities in the vicinity of the equipment under test do not exceed 2,5 m/s.

## A.2 Equipment installation

**A.2.1** The equipment to be tested shall be installed in accordance with the manufacturer’s installation instructions using recommended installation procedures and accessories. If the equipment can be installed in several orientations, the tests shall be conducted using the worst possible orientation.

**A.2.2** No alterations to the equipment shall be made except for the attachment of required test apparatus and instruments in the prescribed manner.

**A.2.3** Where necessary, equipment shall be evacuated and charged with the type and amount of refrigerant specified in the manufacturer’s instructions.

## A.3 Cooling and heating capacity tests

**A.3.1** The test room reconditioning apparatus and the equipment under test shall be operated until equilibrium conditions are attained, but for not less than one hour, before capacity test data are recorded.

**A.3.2** Data shall then be recorded for 30 min at 5-min intervals until seven consecutive sets of readings within the tolerances prescribed in 5.4 have been attained. The avarages of these data shall be used for the calculation of test results.

# Annex B
(normative)

# Indoor air-enthalpy test method

## B.1 General

In the air-enthalpy test method, capacities are determined from measurements of entering and leaving wet- and dry-bulb temperatures and the associated airflow rate.

## B.2 Application

This method shall be employed for the indoor-side tests of all equipment, subject to the additional requirements of annex F. Non-ducted equipment may, alternatively, be tested using the calorimeter room test method described in annex E.

## B.3 Calculations — Cooling

Measured total, sensible, and latent indoor cooling capacities based on the indoor-side test data are calculated by the following equations (see annex G for identification of symbols):

$$\phi_{tci} = q_{mi}(h_{a1} - h_{a2})/[v'_n(1 + W_n)]$$ [4]

$$\phi_{sci} = q_{mi}\, c_{pa}(t_{a1} - t_{a2})/\, [v'_n(1 + W_n)]$$ [4]

$$c_{pa} = 1006 + 1860\, W_n$$

$$\phi_{lci} = 2{,}47 \times 10^6\, q_{mi}\, (W_{i1} - W_{i2})/\, v'_n(1 + W_n)]$$ [5]

$$\phi_{lci} = \phi_{tci} - \phi_{sci}$$

## B.4 Calculations — Heating

**B.4.1** Measured heating capacity based on indoor-side data is calculated by the following equation:

$$\phi_{thi} = q_{mi}\, c_{pa}(t_{a2} - t_{a1})/\, [v'_n(1 + W_n)]$$ [4]

**B.4.2** If line loss corrections are to be made, they shall be included in the capacity calculations.

[4] This equation does not provide allowances for heat leakage in the test equipment.
[5] The latent heat of vaporization of water is 2,47 x $10^6$ J/kg at 15 °C ±1 °C.

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# Annex C
(normative)

# Liquid enthalpy test method

## C.1 General

In the liquid enthalpy test method, capacities are determined from measurements of the liquid temperature change and associated flow rate.

## C.2 Application

This method shall be used for liquid side tests of all equipment, subject to the additional requirements of annex F.

## C.3 Calculations

### C.3.1 Cooling capacity

Measured total cooling capacity based on liquid side data is calculated as follows (see annex G for identification of the symbols):

$$\phi_{tco} = w_f \, c_{pf} \, (t_{f4} - t_{f3}) - \phi_t$$

### C.3.2 Heating capacity

Measured total heating capacity based on liquid side data is calculated as follows:

$$\phi_{tho} = w_f \, c_{pf} \, (t_{f3} - t_{f4}) + \phi_t$$

**C.3.3** If line loss corrections are to be made, they shall be included in the capacity calculations.

# Annex D
(normative)

# Airflow measurement

## D.1 General

**D.1.1** Airflow measurements shall be made in accordance with the provisions specified in ISO 5221, ISO 3966 and ISO 5167, as appropriate, and the provisions in this annex.

**D.1.2** Indoor airflow rates for equipment rated 117 kW and lower shall be measured in accordance with the methods specified in F.3 if the indoor air-enthalpy method is used. The nozzle apparatus described in F.8 is recommended when direct airflow measurement is not employed. The indoor airflow rate shall be determined indirectly as prescribed in D.3.4.

**D.1.3** Indoor airflow rates of equipment rated above 117 kW shall be determined by the methods of D.1.1 or by the modified method of D.3.5.

## D.2 Applications

This test method shall be employed for the air-side tests of all equipment subject to the additional requirements of annex F. Non-ducted equipment may, optionally, be tested using the calorimeter room test method described in annex E.

## D.3 Calculations

### D.3.1 Single nozzle

The airflow rate through a single nozzle is calculated by the following equations (see annex G for identification of the symbols):

$$q_{mi} = 1{,}414\ C_d A_n\ (1000\ p_v\ v'_n)^{0{,}5}$$

$$v'_n = 101\ v_n\ /[p_n\ (1 + W_n)]$$

### D.3.2 Multiple nozzles

When more than one nozzle is used, the total airflow rate is the sum of the flow rates of the individual nozzles calculated in accordance with D.3.1.

### D.3.3 Equation

The flow rate of standard air is calculated as follows

$$q_s = q_{mi}/(1{,}2\ v'_n)$$

### D.3.4 Indirect determination of airflow

When direct airflow measurement is not employed, the airflow rate shall be determined by calculation as follows:

$$q_i = \phi_{tci}\ v_{i1}/(h_{a1} - h_{a2}) \quad \text{(cooling)}$$
$$q_i = \phi_{tci}\ v_{i1}/(h_{a2} - h_{a1}) \quad \text{(heating)}$$

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### D.3.5 Calculations for modified airflow measurement method

**D.3.5.1** If the modified airflow method is selected (see figure D.1 for apparatus), low-side air quantity shall be determined from the following equations:

$$w_{a1} = \phi_{sri}/1006 + 1860\ W_{i2}\ (t_{a5} - t_{a1})$$

$$q_i = w_{a1}\, v_{a1}$$

$$q_s = \phi_{sri}/1,204\ (t_{a5} - t_{a1})$$

**D.3.5.2 Determination of $\phi_{sri}$**

a) If electric reheat is used: $\phi_{sri}$ = watts input to heater

b) If steam coil reheat is used: $\phi_{sri} = w_k(h_{k1} - h_{k2})$

Dimensions in metres

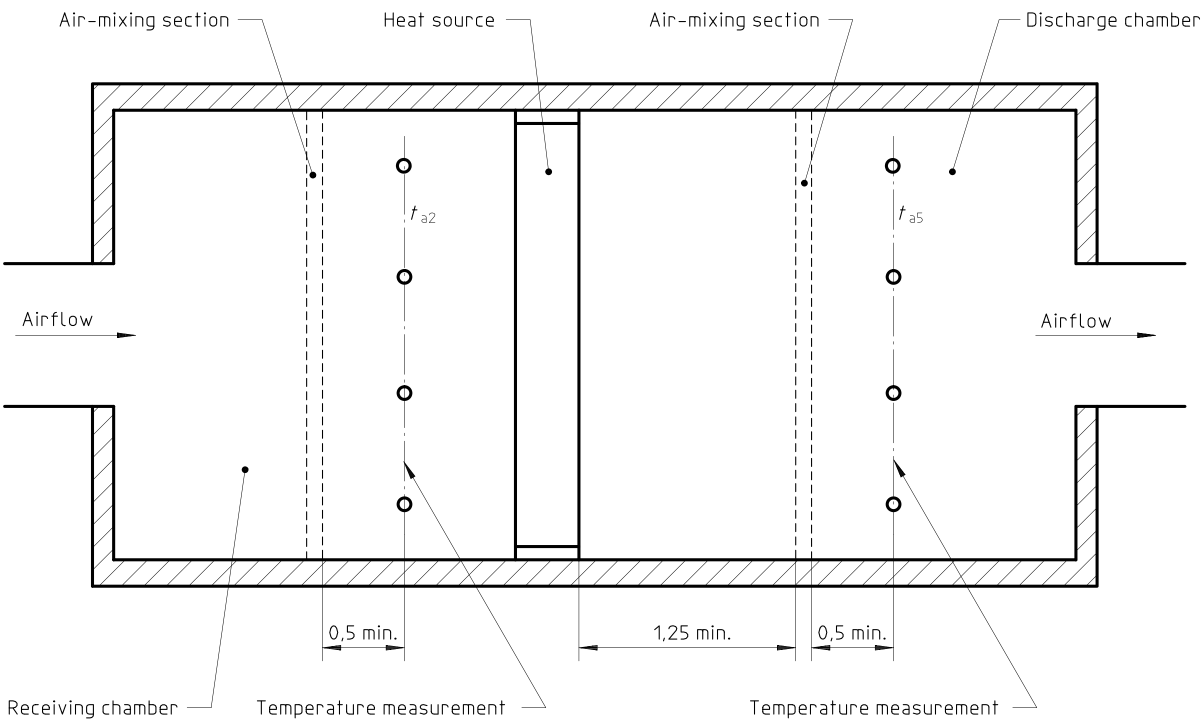


**Figure D.1 — Alternative airflow measurement apparatus**

# Annex E
(normative)

# Calorimeter room test method

## E.1 General

**E.1.1** The calorimeter room provides an alternative test method for determining the indoor-side capacity for non-ducted heat pumps. In the cooling mode, the indoor-side capacity determination is made by balancing the cooling and dehumidifying effects of the equipment with measured heat input and condensate output. In the heating mode, the indoor-side capacity determination is made by balancing the heating effect of the equipment with measured heat removed from the room.

**E.1.2** The size of the calorimeter be sufficient to avoid any restriction to the intake or discharge openings of the heat pump. Perforated plates or other suitable grilles shall be provided at the discharge opening from the reconditioning apparatus to avoid face velocities exceeding 0,5 m/s. Sufficient space shall be allowed in front of any inlet or discharge grilles of the heat pump to avoid interference with the airflow. Minimum distance from the heat pump to the side walls or ceiling of the compartment(s) shall be 1 m, except for the back of console-type equipment, which shall be in a normal relationship to the wall. Table E.1 gives the suggested dimensions for the calorimeter room. To accomodate unusual sizes of units, it may be necessary to alter the suggested dimensions to comply with the space requirements.

**Table E.1 — Dimensions of calorimeter room**

| Maximum rated cooling capacity of equipment* | Suggested minimum inside dimensions of calorimeter room | | |
|---|---|---|---|
| | Width | Height | Length |
| W | m | m | m |
| 3,000 | 2,4 | 2,1 | 1,8 |
| 6,000 | 2,4 | 2,1 | 2,4 |
| 9,000 | 2,7 | 2,4 | 3,0 |
| 12,000 | 3,0 | 2,4 | 3,7 |

* All figures are round numbers

**E.1.3** The calorimeter room shall be provided with appropriate reconditioning apparatus to the maintain the specified airflow and prescribed conditions. The reconditioning apparatus shall consist of heaters to supply sensible heat, a humidifier to supply moisture, and a chilled water coil to provide cooling and dehumidification (see figures E.1 and E.2). The energy supply should be controlled and measured.

**E.1.4** The reconditioning apparatus shall be provided with fans of sufficient capacity to ensure airflows of not less than twice the quantity of air discharged by the equipment under test in the calorimeter, and air velocities at the discharge of reconditioning apparatus of less than 1 m/s. The calorimeter be equipped with means of measuring or determining specified wet- and dry-bulb temperatures.

**E.1.5** It is recognized that temperature gradients and airflow patterns will result from the interaction of the reconditioning apparatus and test equipment. Therefore, the resultant conditions are peculiar to and dependent upon a given combination of compartment size, arrangement and size of the reconditioning apparatus, and the air discharge characteristics of the equipment under test.

The point of measurement of specified test temperatures, both wet- and dry-bulb, shall be such that the following conditions are fulfilled.

a) The measured temperature shall be representative of the temperature surrounding the unit, and simulate the conditions encountered in an actual application, as indicated above.

b) At the point of measurement, the temperature of the air shall not be affected by the air discharged from the test unit. This makes it mandatory that the temperatures are measured upstream of any recirculation produced by the test unit.

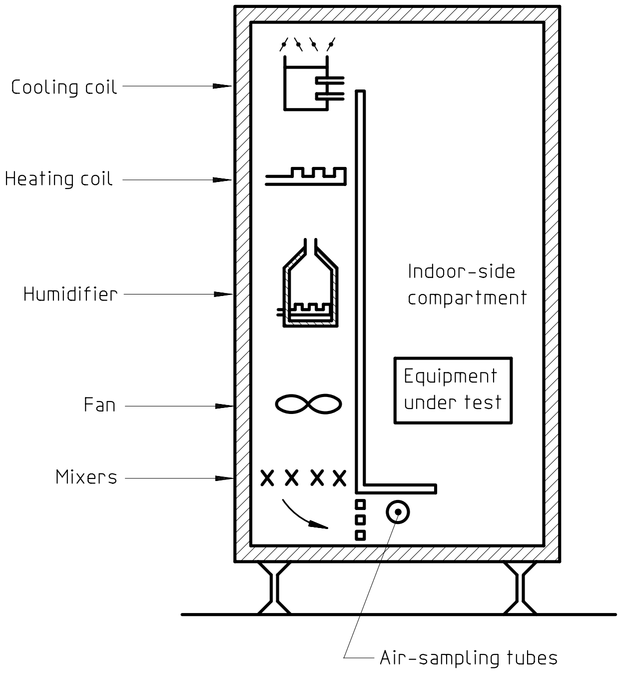


**Figure E.1 — Typical calibrated room-type calorimeter**

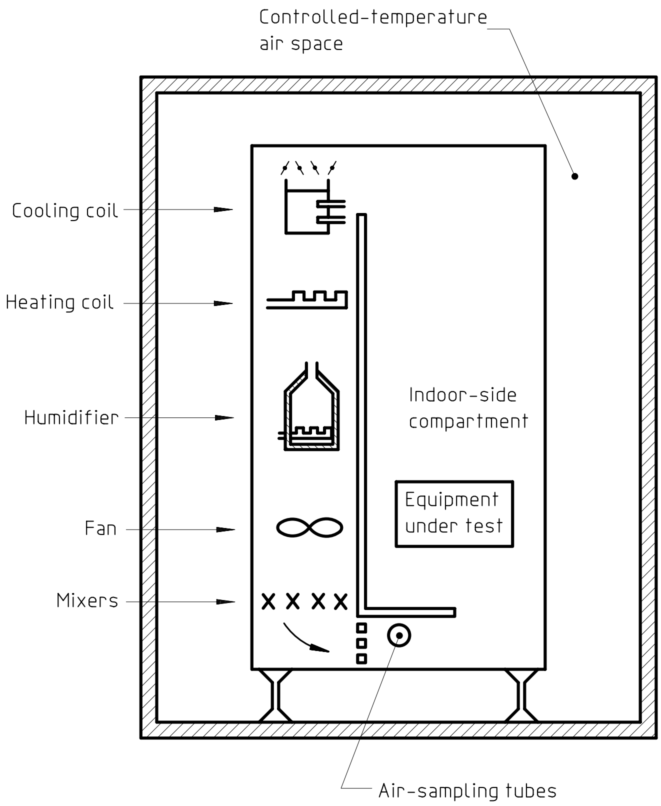


**Figure E.2 — Typical balanced ambient room-type calorimeter**

**E.1.6** Interior surfaces of the calorimeter room shall be of non-porous material with all joints sealed against air and moisture leakage. The access door shall be tightly sealed against air and moisture leakage by use of gaskets or other suitable means.

## E.2 Calibrated calorimeter room

**E.2.1** The calibrated calorimeter room is shown in figure E.1. The calorimeter room shall be insulated to prevent heat leakage (including radiation) in excess of 5 % of the capacity of the test unit. An air space permitting free circulation shall be provided under the calorimeter floor.

**E.2.2** Heat leakage may be determined by the following method: All openings shall be closed. The calorimeter room may be heated by electric heaters to a temperature of at least 11 °C above the surrounding ambient temperature. The ambient temperature shall be maintained constant to within ±1 °C outside all six enveloping surfaces of the calorimeter room.

**E.2.3** The performance of the calorimeter room shall be verified at least every 6 months using an industrial standard cooling capacity calibrating device. The calibrating device may also be a test unit whose performance has been measured at an accredited nationally recognized testing laboratory.

## E.3 Balanced ambient calorimeter room

**E.3.1** The balanced ambient calorimeter room is shown in figure E.2 and is based on the principle of maintaining the dry-bulb temperatures surrounding the calorimeter room equal to the dry-bulb temperatures maintained within that room. If the ambient wet-bulb temperature is also maintained equal to that within the room, the vapour-proofing provisions of E.1.6 are not required.

**E.3.2** The floor, ceiling and walls of the calorimeter room shall be spaced a sufficient distance away from the floor, ceiling and walls of the controlled areas in which the calorimeter room is located in order to provide a uniform air temperature in the intervening space. It is recommended that this distance be at least 0,3 m. Means shall be provided to circulate the air within the surrounding space to prevent stratification.

**E.3.3** It is recommended that the floor, ceiling, and walls of the calorimeter room be insulated so as to limit heat leakage (including radiation) to no more than 10 % of the capacity of the test equipment, with an 11 °C temperature difference, or 300 W for the same temperature difference, whichever is greater, as tested using the procedure given in E.2.2.

## E.4 Cooling capacity calculations

**E.4.1** The total cooling capacity, as tested in either the calibrated calorimeter room or the balanced-ambient calorimeter room (see figures E.1 and E.2), is calculated as follows:

$$\phi_{tci} = \Sigma\phi_r + (h_{w1} - h_{w2})\, w_r + \phi_{lr} \qquad \text{(E.1)}$$

where

$\phi_{tci}$ is the total cooling capacity as determined in the indoor-side, in watts.

$\Sigma\phi_r$ is the sum of all power input to the indoor-side, in watts.

$h_{w1}$ is the specific enthalpy of water or steam supplied to maintain humidity. If no water is introduced during the test, $h_{w1}$ is taken at the temperature of the water in the humidifier tank of the reconditioning apparatus, in kilojoules per kilogram.

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$h_{w2}$ is the specific enthalpy of the condensed moisture leaving the calorimeter room.

When it is not practical to measure this temperature, the temperature of the condensate may be assumed to be at the measured, or estimated, wet-bulb temperature of the air leaving the test equipment, in kilojoules per kilogram.

$w_r$ is the water vapour (rate) condensed by the equipment under test. This is measured as the amount of water evaporated into the calorimeter room by the reconditioning apparatus to maintain the required humidity, in grams per second.

$\phi_{lr}$ is the heat leakage rate into the calorimeter room through walls, floor, and ceiling, as determined from the calibrating test, in watts.

## E.5 Heating capacity calculations

**E.5.1** Determination of the heating capacity by measurement in the calorimeter room is calculated as follows:

$$\phi_{hi} = \phi_{lci} + \phi_{li} - P_i \quad \text{(E.2)}$$

where

$\phi_{hi}$ is the heating capacity as determined in the calorimeter room, in watts.

$\phi_{lci}$ is the heat flow removed from the calorimeter room, in watts.

$\phi_{li}$ is the heat flow through the remaining enveloping surfaces of the calorimeter room, in watts

$P_i$ is the other power input to the calorimeter room (e.g., illumination, electrical, and thermal power input to the compensating device, heat balance of the humidification device), in watts.

# Annex F
(informative)

# Instrumentation and measurements

## F.1 Temperature

**F.1.1** Temperature should be measured using liquid-in-glass thermometers, thermocouples, or electric resistance thermometers, including thermistors. The instrument characteristics of table F.1 should be met.

**F.1.2** In-duct temperature measurements should be taken at not less than three locations at the centres of equal segments of the cross-sectional area, or suitable sampling or mixing devices giving equivalent results should be provided. Connections to the equipment should be insulated between the place of measurement and the equipment so that heat leakage through the connections does not exceed 1,0 % of the capacity.

**F.1.3** The indoor inlet air temperature should be measured in at least three positions equally spaced over the equipment inlet area, or equivalent sampling means provided. For equipment without duct connections or enclosures, the temperature measuring instruments or sampling devices should be located approximately 15 cm from the equipment inlet opening or openings.

**Table F.1 — Instrument tolerances for temperature measurements**

| Item measured | Instrument accuracy | Instrument precision | Range within which measurements are usually found |
|---|---|---|---|
| Air dry-bulb temperature, °C | ±0,1 | ±0,05 | –29 to 60 |
| Air wet-bulb temperature, °C | ±0,1 | ±0,05 | –18 to 32 |
| Liquid temperatures, °C | ±0,1 | ±0,05 | –10 to 50 |

**F.1.4** Air velocities over the wet-bulb temperature measuring instruments should be approximately 5 m/s. It is recommended that the same air velocity be used for inlet and outlet measurements.

**F.1.5** In no case should the smallest scale division of the temperature measuring instrument exceed twice the specified accuracy. For example, for the specified accuracy of ±0,05 °C, the smallest scale division should not exceed 0,1 °C.

**F.1.6** Where an instrument accuracy of ±0,05 °C is specified, the instrument should be calibrated by comparison with a thermometer certified by a recognized authority, such as a national standards laboratory.

**F.1.7** Temperature measuring instruments used to measure the change in temperature should be arranged so that they can be readily interchanged between inlet and outlet positions to improve accuracy.

**F.1.8** Temperature of liquids within conduits should be measured by inserting the temperature measuring instrument directly within the liquid, or within a well inserted into the liquid. If a glass thermometer is to be inserted directly into the liquid, it should be calibrated for the effect of pressure.

**F.1.9** Temperature measuring instruments should be adequately shielded from radiation from any adjacent heat sources.

**F.1.10** Air temperature measurements should be taken upstream of static pressure taps on the inlet and downstream of the static pressure taps on the outlet.

## F.2 Pressure

**F.2.1** Pressure measurements should be made with one or more of the following instruments:

a) mercury columns,

b) bourdon tube gauges, or

c) electronic pressure tranducers.

**F.2.2** The accuracy of the pressure measuring instruments should be within ±2,0 % of the indicated value.

**F.2.3** In no case should the smallest scale division of the pressure measuring instrument exceed 2,5 times the specified accuracy.

## F.3 Airflow and static pressure

**F.3.1** Static pressures across nozzles and velocity pressures at nozzle throats should be measured with manometers which have been calibrated against a standard manometer to ±1,0 % of the reading. The smallest manometer scale reading should not exceed 2,0 % of the reading.

**F.3.2** Duct static pressure should be measured with manometers having an accuracy of ±2,5 Pa.

**F.3.3** Areas of nozzles should be determined by measuring their diameters to an accuracy of ±0,2 % in four locations approximately 45° apart around the nozzle in each of two places through the nozzle throat, one at the outlet and the other in the straight section near the radius.

## F.4 Electrical measurements

**F.4.1** Electrical measurements should be made with either indicating or integrating instruments.

**F.4.2** Instruments used for measuring the electrical input to heaters or other apparatus furnishing heat loads should be accurate to ±1,0 % of the quantity measured. Instruments used for measuring electrical input to fan motors, compressor motors, or other electrical accessories should be accurate to ±1,0 % of the indicated value.

**F.4.3** Voltages should be measured at the equipment terminals.

## F.5 Liquid flow measurement

**F.5.1** Water and brine flow rates should be measured with a liquid flow meter or quantity meter having an accuracy of ±1,0 % of the indicated value.

**F.5.2** Condensate collection rates should be measured with a liquid quantity meter measuring either mass or volume and having an accuracy of ±1,0 % of the indicated value.

## F.6 Time, mass and speed measurements

**F.6.1** Time measurements should be made with instruments having an accuracy of ±0,20 %.

**F.6.2** Mass measurements should be made with apparatus having an accuracy of ±0,20 %.

**F.6.3** Speed measurements should be made with a revolution counter, tachometer, stroboscope or oscilloscope having an accuracy of ±1,0 %.

## F.7 Airflow enthalpy measurements

One of the following test apparatus arrangements is recommended unless the calorimeter room test method described in annex E is used for non-ducted equipment.

### F.7.1 Tunnel air-enthalpy method (see figure F.1)

The equipment to be tested is typically located in a test room or rooms. An air measuring device is attached to the equipment indoor air discharge. This device discharges directly into the test room or space, which should be provided with suitable means for maintaining the air entering the equipment at the desired wet- and dry-bulb temperatures. Suitable means for measuring the wet- and dry-bulb temperatures of the air entering and leaving the equipment and the external resistance should be provided.

### F.7.2 Loop air-enthalpy method (see figure F.2)

This arrangement differs from the tunnel arrangement in that the air measuring device discharge is connected to suitable reconditioning apparatus which is, in turn, connected to the equipment inlet. The resulting test “loop” should 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 should be maintained within ±3,0 °C of the desired test inlet dry-bulb temperature. Wet- and dry-bulb temperatures and external resistance should be measured by suitable means.

### F.7.3 Enclosure air-enthalpy method (see figure F.3)

In this arrangement, an enclosure is placed over the equipment under test, or the applicable part of the equipment. This enclosure may be constructed of any suitable material, but should be nonhydroscopic, be airtight and preferably insulated. It should be large enough to permit inlet air to circulate freely between the equipment and the enclosures, and in no case should the enclosure be closer than 15 cm 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 to be connected to the equipment discharge. This device should be well insulated where it passes through the enclosed space. Wet- and dry-bulb temperatures of the air entering the equipment are to be measured at the enclosure inlet. Temperature and external resistance measurements are to be made by suitable means.

### F.7.4 Room air-enthalpy method (see figure F.4)

The equipment to be tested is typically located in the test rooms. An air-measuring device is to be attached to the equipment indoor air discharge, then, in turn, connected to suitable reconditioning equipment. The discharge air from the reconditioning appartus provides the desired wet- and dry-bulb temperatures where air-sampling devices and manometers can measure wet- and dry-bulb temperatures and external resistance, as required.

### F.7.5 General

The arrangements shown in figures F.1, F.2, F.3 and F.4 are intended to illustrate various possibilities available and should not be construed as applying specifically or solely to the types of equipment with which they are shown. However, an enclosure as shown in figure F.3 should be used when the compressor is in the indoor section and separately ventilated.

### F.7.6 Alternatives

Other means of handling the air leaving the airflow measuring device and supplying air at the proper conditions to the equipment inlet may be employed provided that they do not interfere with the external resistance measurements or create abnormal conditions surrounding the equipment.

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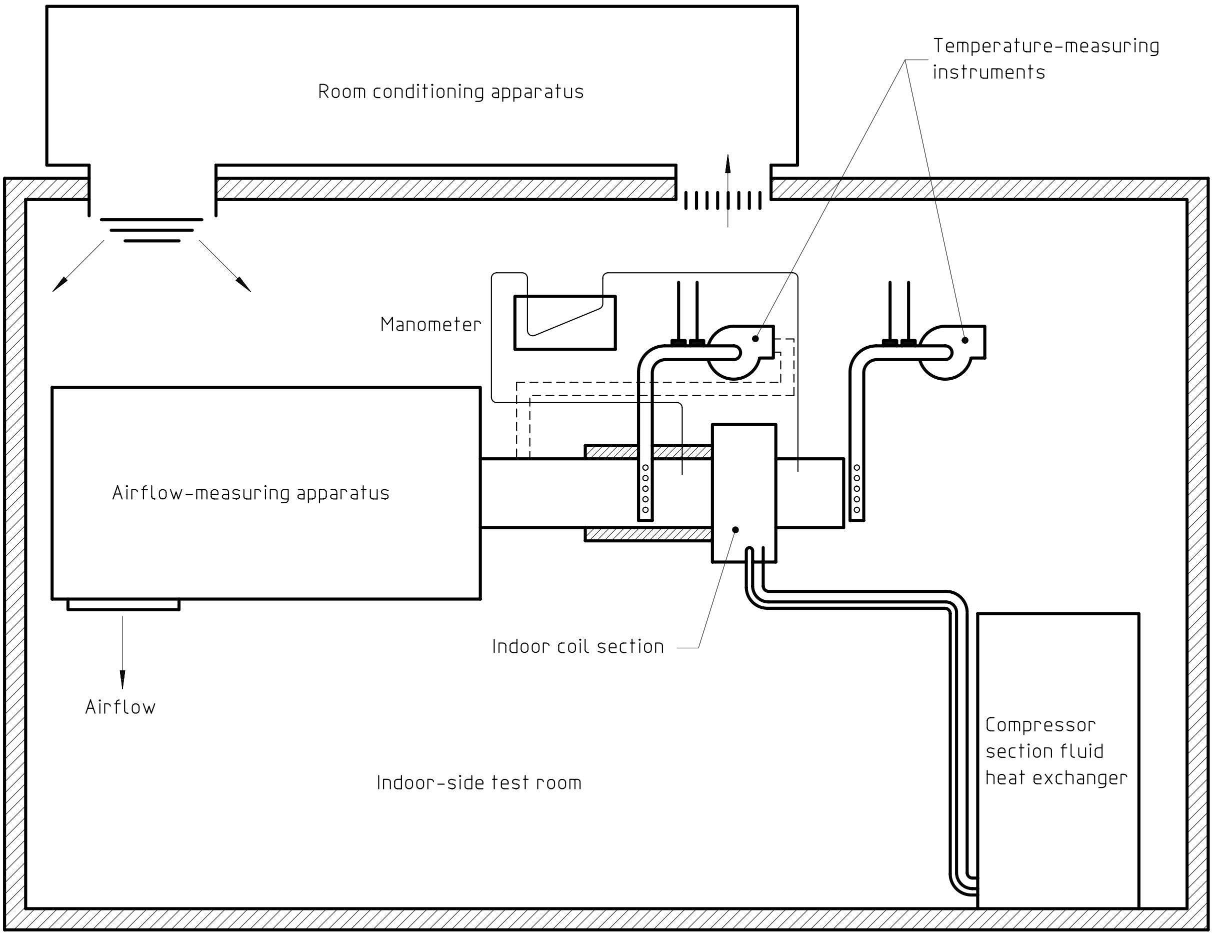


**Figure F.1 — Arrangement for tunnel air-enthalpy test method**

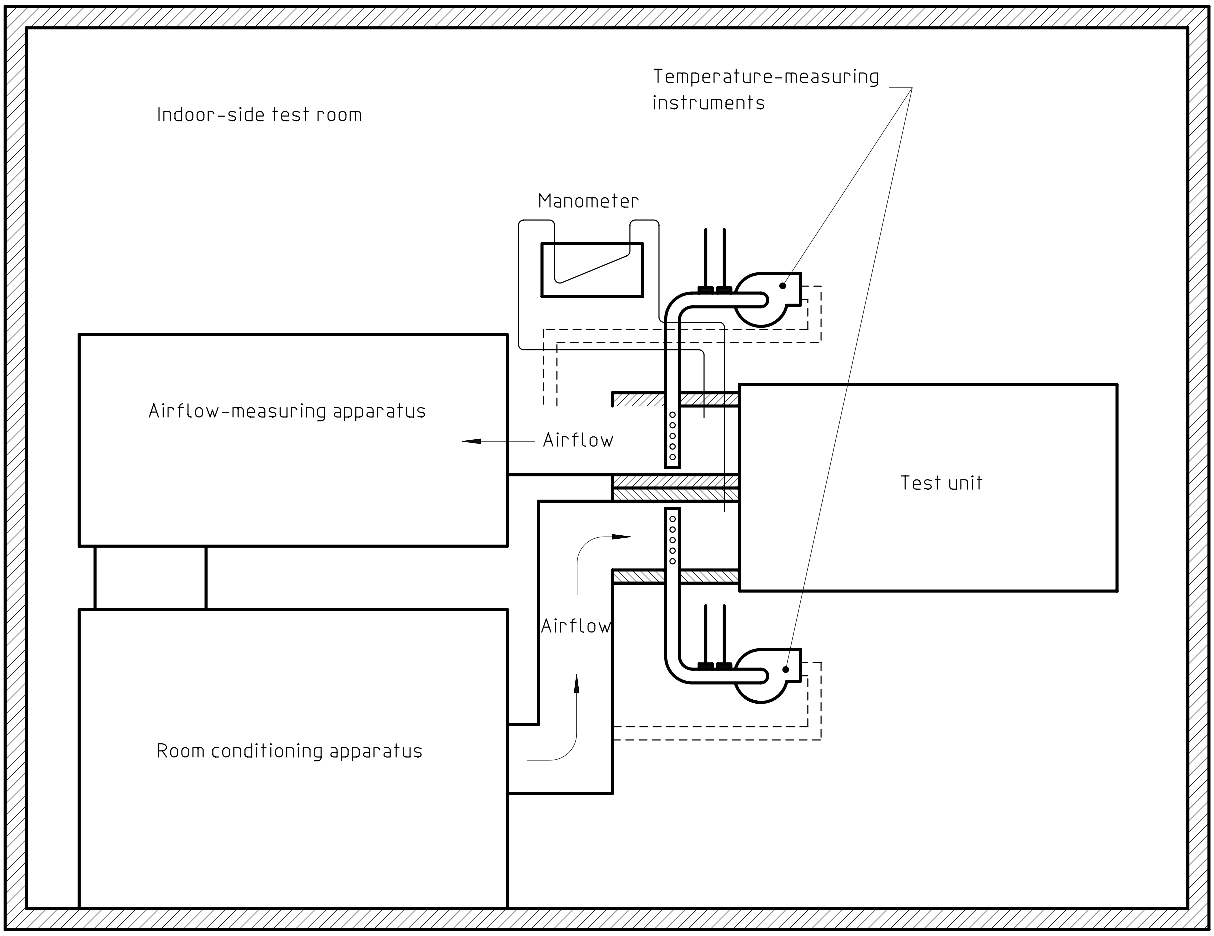


**Figure F.2 — Arrangement for loop air-enthalpy test method**

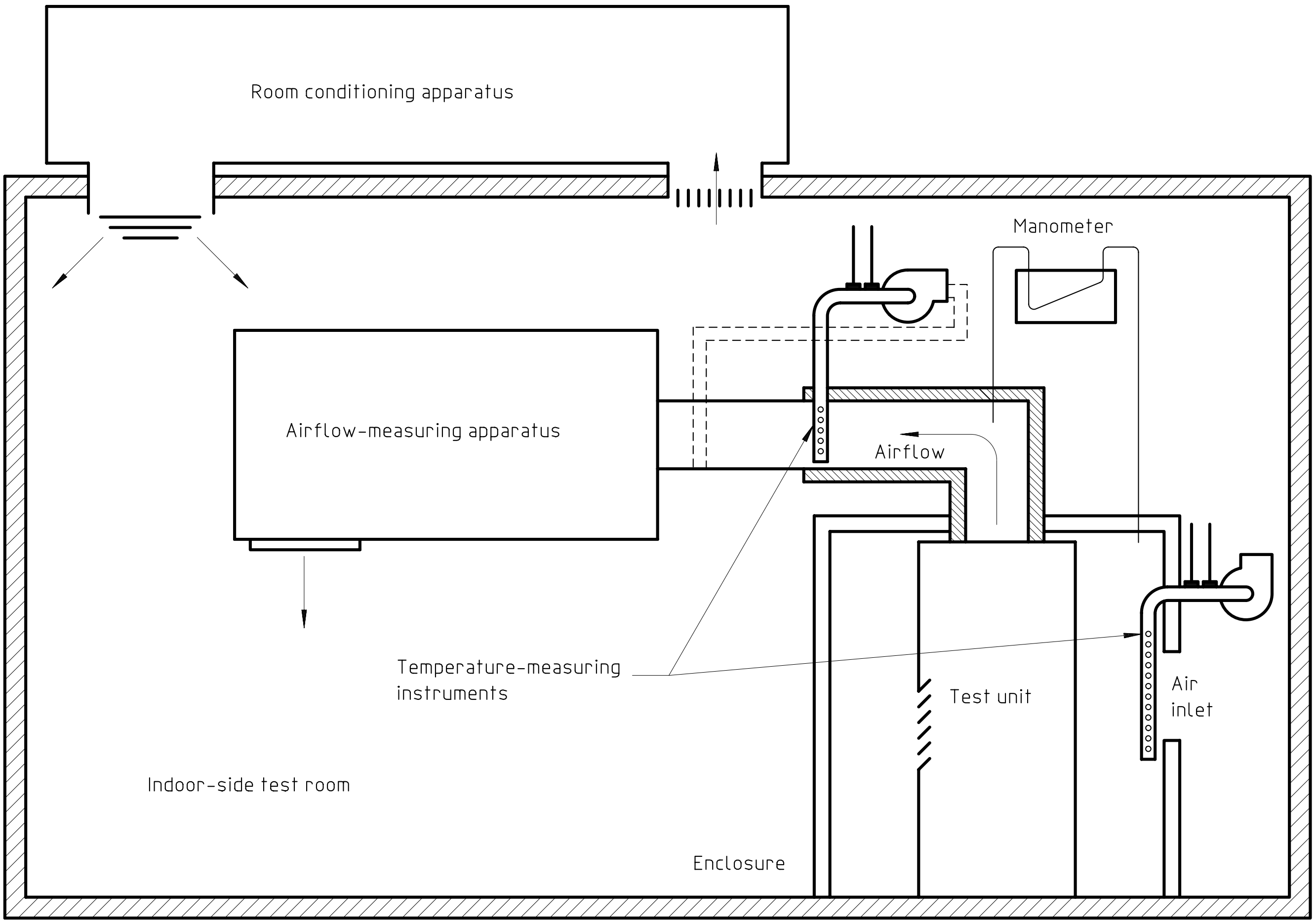


**Figure F.3 — Arrangement for enclosed air-enthalpy test method**

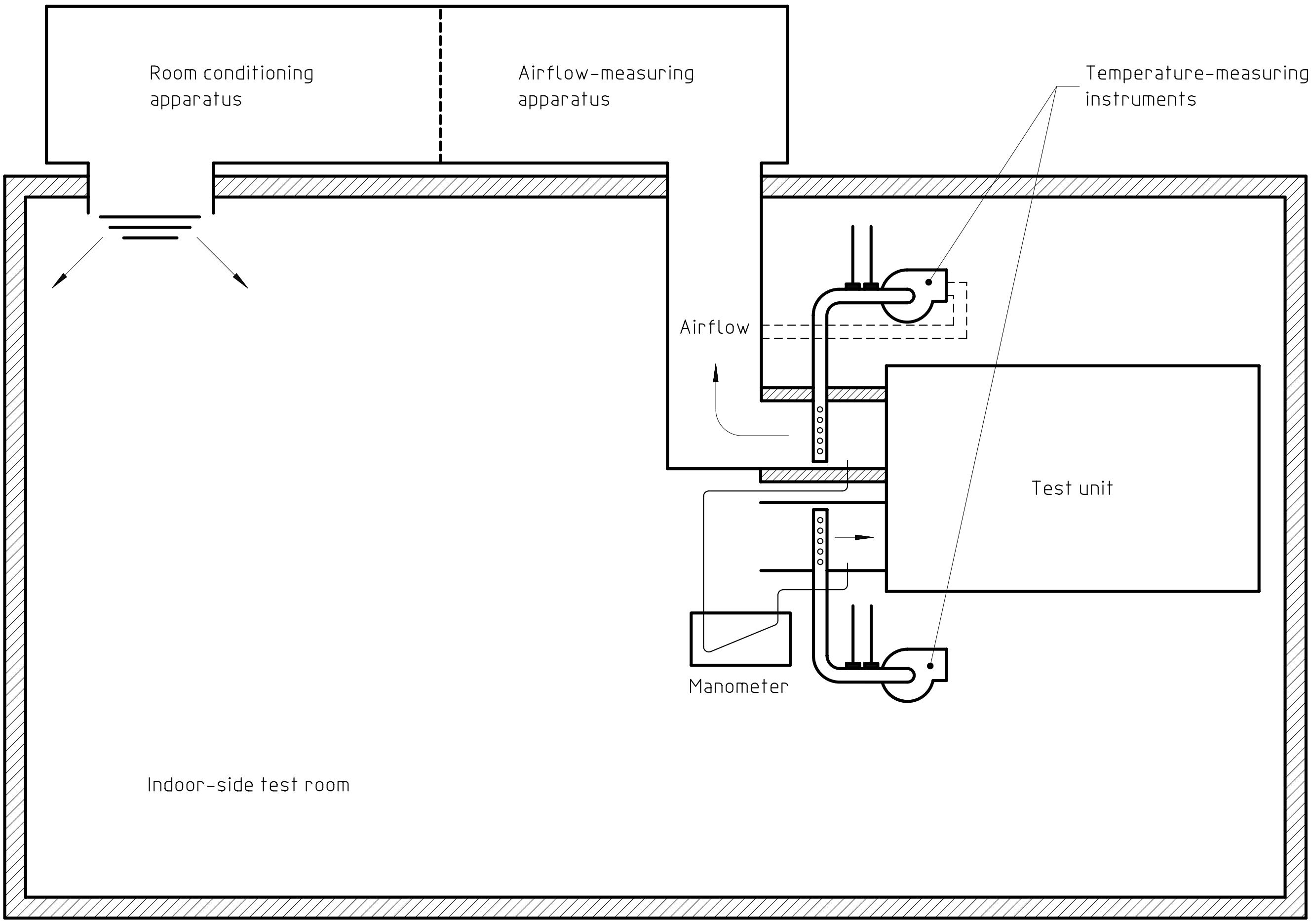


**Figure F.4 — Arrangement for room air-enthalpy test method arrangement**

## F.8 Nozzle apparatus

**F.8.1** The nozzle apparatus consists of a receiving chamber and a discharge chamber separated by a partition in which one or more nozzles are located (see figure F.5). Air from the equipment under test is conveyed via a duct to the receiving chamber, passes through the nozzle or nozzles, and is then exhausted to the test room or channeled back to the equipment inlet.

**F.8.2** The nozzle apparatus and its connections to the equipment inlet should be sealed so that air leakage does not exceed 1,0 % of the airflow rate being measured.

**F.8.3** The centre-to-centre distance between nozzles in use should be not less than 3 times the throat diameter of the larger nozzle, and the distance from the centre of any nozzle to the nearest discharge or receiving chamber side wall should not be less than 1,5 times its throat diameter.

**F.8.4** Diffusers should be installed in the receiving chamber (at a distance at least 1,5 times the largest nozzle throat diameter) upstream of the partition wall and in the discharge chamber (at a distance at least 2,5 times the nozzle throat diameter) downstream of the partition wall.

**F.8.5** An exhaust fan, capable of providing the desired static pressure at the equipment outlet, should be installed in one wall of the discharge chamber and means should be provided to vary the capacity of this fan.

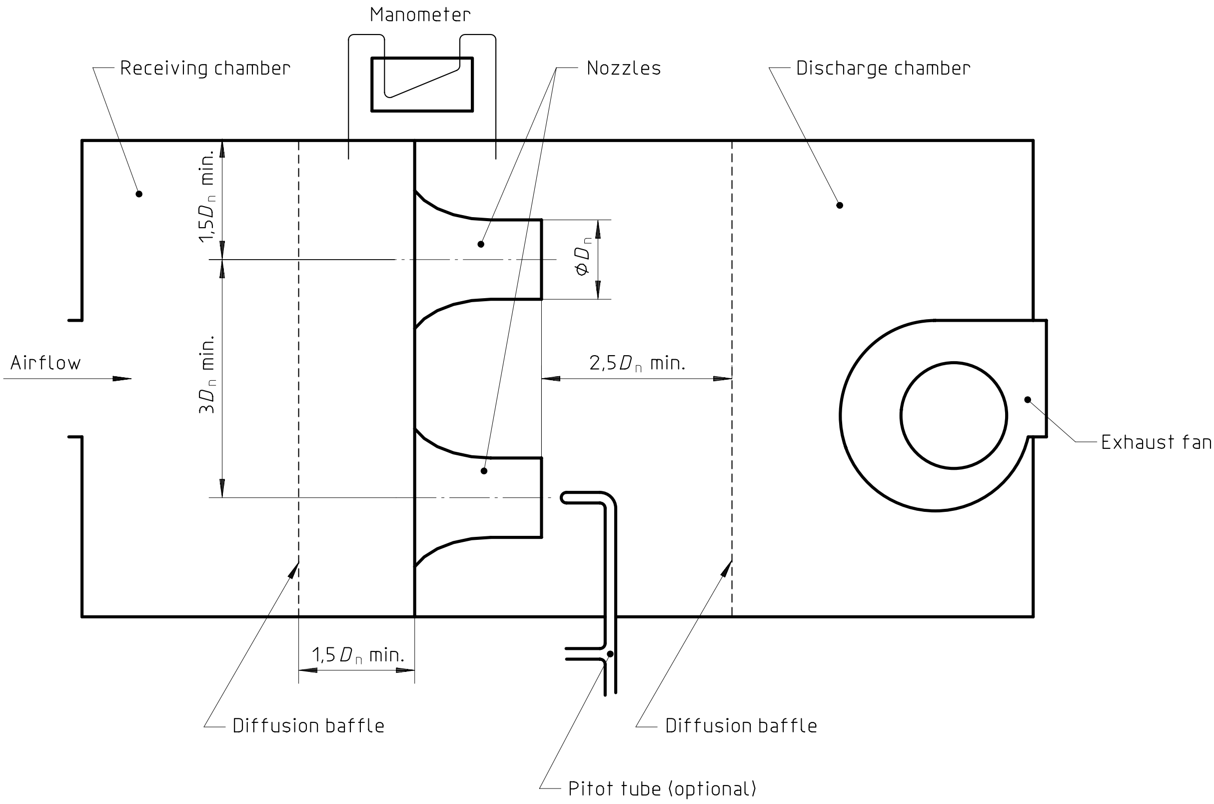


**Figure F.5 — Airflow measuring apparatus**

**F.8.6** The static pressure drop across the nozzle or nozzles should be measured with a manometer. One end of the manometer should be connected to a static pressure tap located flush with the inner wall of the receiving chamber and the other end to a static pressure tap located flush with the inner wall of the discharge chamber, or preferably, several taps in each chamber should be connected to several manometers in parallel or manifolded to a single manometer. Alternately, the velocity head of the air stream leaving the nozzle or nozzles may be measured by a pitot tube as shown in figure F.5, but when more than one nozzle is in use, the pitot tube reading should be determined for each nozzle.

**F.8.7** Means should be provided to determine the air density at the nozzle throat.

**F.8.8** The throat velocity of any nozzle in use should be not less than 15 m/s, nor more than 35 m/s.

**F.8.9** When nozzles are constructed in accordance with figure F.6, and installed in accordance with the provisions of this annex, they may be used without calibration. If the throat diameter is 12,5 cm or larger, the coefficient may be assumed to be 0,99. For nozzles smaller than 12,5 cm in diameter, or where a more precise coefficient is desired, the following values may be used, preferably, the nozzle should be calibrated:

| Reynolds number, *Re* | Coefficient discharge, *C* |
|---|---|
| 50 000 | 0,97 |
| 100 000 | 0,98 |
| 150 000 | 0,98 |
| 200 000 | 0,99 |
| 250 000 | 0,99 |
| 300 000 | 0,99 |
| 40 0000 | 0,99 |
| 50 0000 | 0,99 |

Reynolds number is calculated as follows:

$$Re = fV_nD_n$$

The temperature factor, *f*, is as follows:

| Temperature, °C | Factor, *f* |
|---|---|
| –6,5 | 78,2 |
| +4,5 | 72,0 |
| 15,5 | 67,4 |
| 26,5 | 62,8 |
| 38 | 58,1 |
| 49 | 55,0 |
| 60 | 51,9 |
| 71 | 48,8 |

## F.9 Static pressure measurements

### F.9.1 Equipment with a fan and a single outlet

**F.9.1.1** As shown in figure F.7, a short plenum chamber should be attached to the outlet of the discharge side of the equipment, where external static pressure measurements are required. This plenum should discharge into an air measuring device (or a suitable dampering device when direct air measurement is not employed), and should have cross-sectional dimensions equal to the dimensions of the equipment outlet.

**F.9.1.2** External static pressure should be measured by a manometer. One side of the manometer should be connected to four externally manifolded pressure taps in the discharge plenum, these taps being centred in each plenum face at a distance of twice the mean cross-sectional dimension from the equipment outlet. If an inlet duct connection is employed, the other side of the manometer should be connected to four externally manifolded pressure taps centred in each face of the inlet duct. If no inlet duct connection is employed, the other side of the manometer should be open to the surrounding atmosphere. Inlet duct connections should have cross-section dimensions equal to those of the equipment (see figure F.8).

### F.9.2 Equipment with fans and multiple outlets

**F.9.2.1** Equipment with multiple discharge outlet duct connections should have a short plenum and should discharge into a single common duct section, the duct section in turn discharging into the air-measuring device. Each plenum should have an adjustable restrictor located in the plane where the plenums enter the common duct section for the purpose of equalizing the static pressure in each plenum.

**F.9.2.2** Multiple blower units employing a single discharge duct connection flange should be tested with a single plenum in accordance with F.9.1.1. No other test plenum arrangements should be used except to simulate duct designs specifically recommended by the equipment manufacturer.

### F.9.3 Equipment without fans

**F.9.3.1** For indoor coil sections which do not incorporate a fan, the inlet and outlet duct connections should have cross-section dimensions equal to the duct flanges of the supplied or recommended coil enclosure.

**F.9.3.2** The internal static air pressure difference should be measured by a manometer as shown in figure F.8. One side of the manometer should be connected to four externally manifolded pressure taps in the outlet duct, these taps being centred in each duct face located at the distance from the coil casing as shown. The other side of the manometer should be connected to four externally manifolded pressure taps centred in each inlet duct face located at the distance from the coil casing as shown.

### F.9.4 General requirements for static pressure measurements

**F.9.4.1** It is recommended that the pressure taps consist of 6,25 mm diameter nipples soldered to the outer plenum surfaces and centred over 1 mm diameter holes through the plenum. The edges of these holes should be free of burrs and other surface irregularities.

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**F.9.4.2** The plenum and duct section should be sealed to prevent air leakage, particularly at the connections to the equipment and the air measuring device, and should be insulated to prevent heat leakage between the equipment outlet and the temperature measuring instruments.

## F.10 Liquid enthalpy measurements

The equipment to be tested is typically located in a test room. A liquid flow measuring device, attached to the equipment, is installed in the refrigerant line to the indoor-side coil.

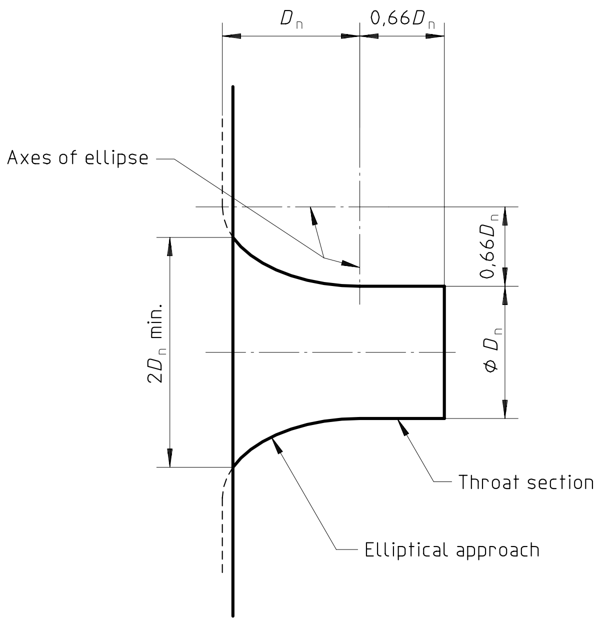
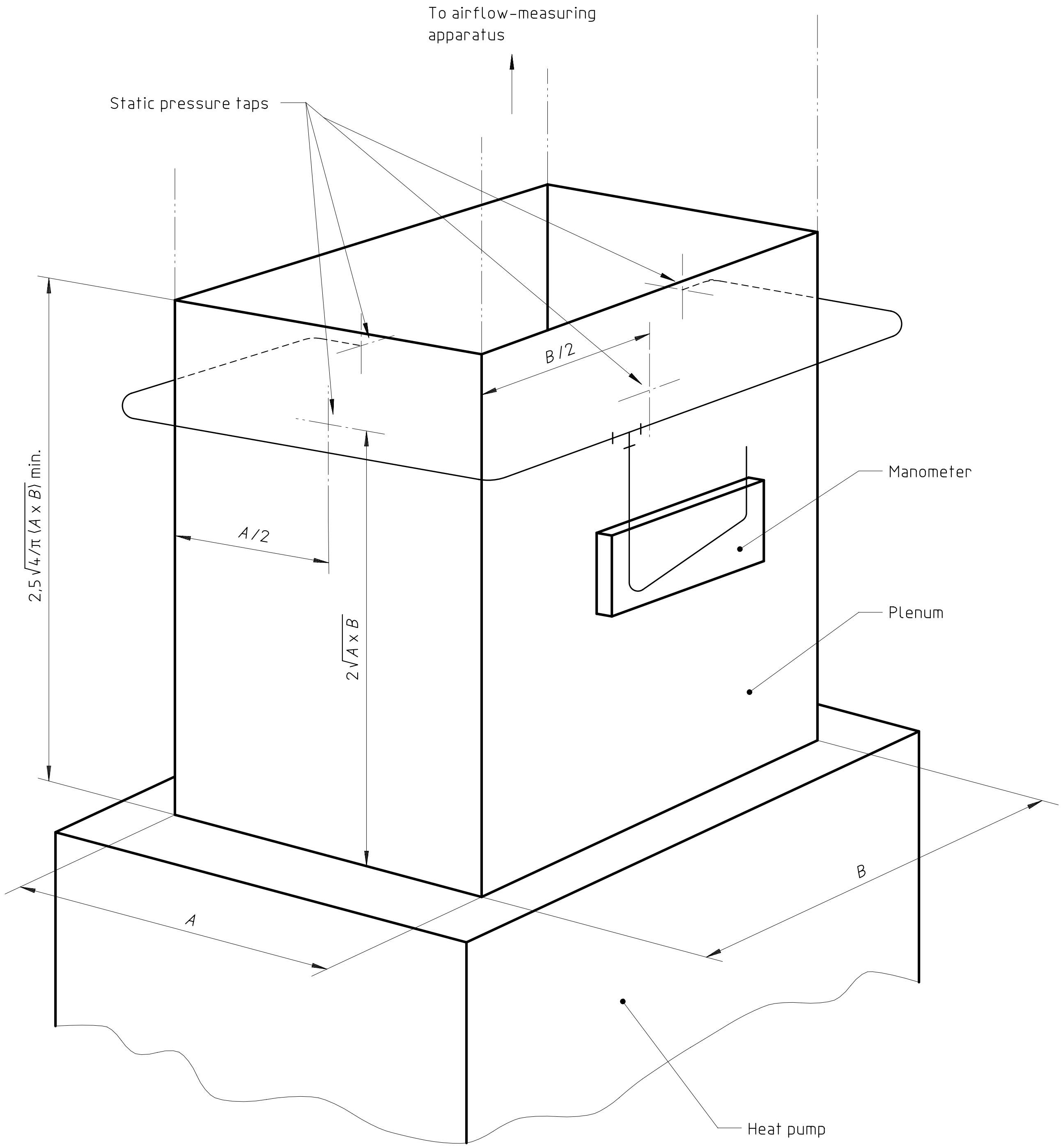
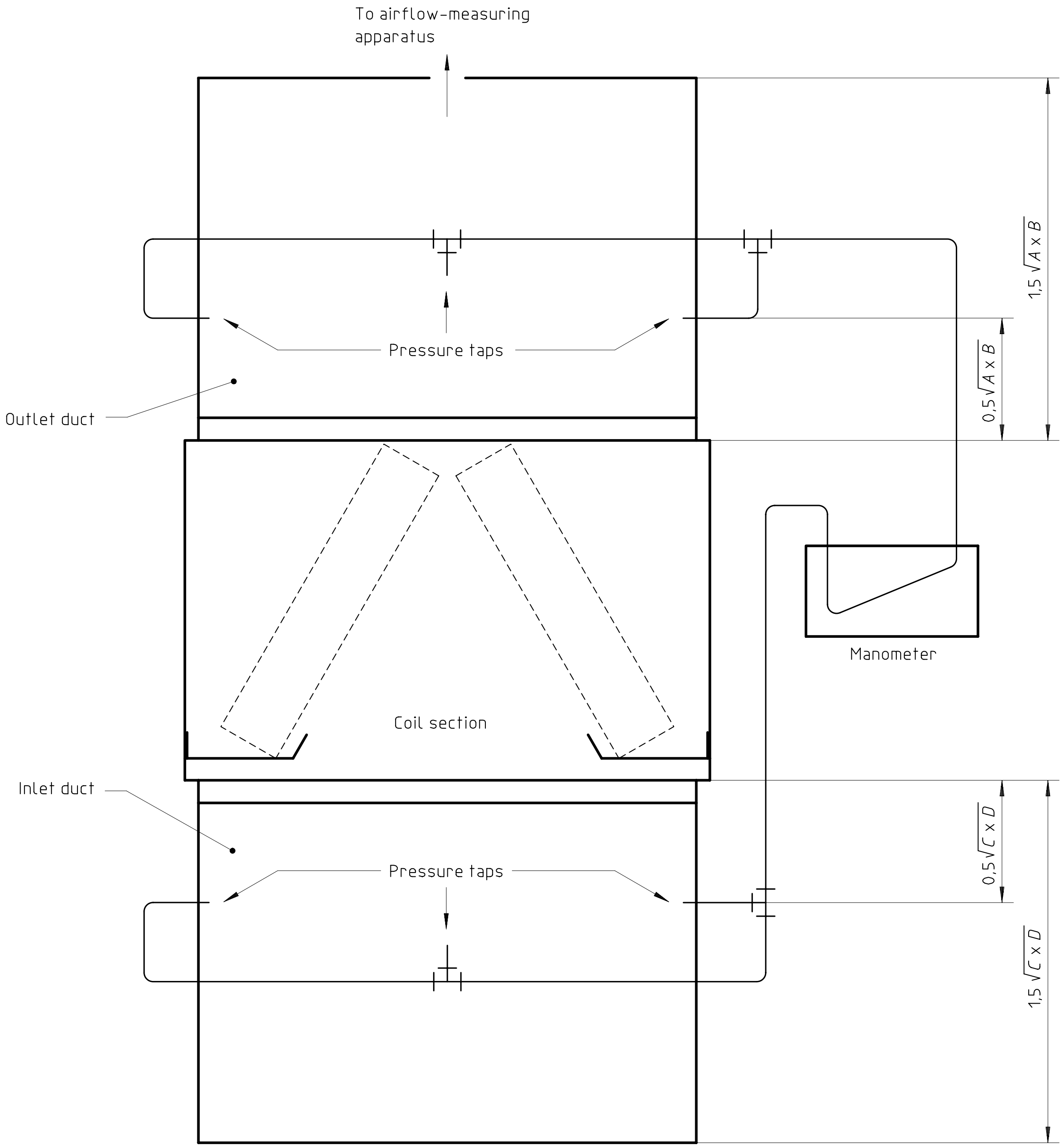



**Figure F.6 — Airflow measuring nozzle**




NOTE — *A* and *B* are outlet dimensions.

**Figure F.7 — External static pressure measurements**




NOTE — *A* and *B* are outlet dimensions.
*C* and *D* are inlet dimensions.

**Figure F.8 — Internal static air pressure difference measurements for coil section without a fan**

# Annex G
(informative)

## Symbols used in annexes

| Symbol | Description and units |
|---|---|
| $A_n$ | area of nozzle, m$^2$ |
| $C_d$ | coefficient of discharge, nozzle |
| $c_{pa}$ | specific heat of dry air, J/kg·K |
| $c_{pf}$ | specific heat of liquid, J/kg·K |
| $D_n$ | diameter of nozzle throat, mm |
| $f$ | temperature factor for *Re* |
| $h_{a1}$ | enthalpy of wet air entering indoor air-side, J/kg of dry air |
| $h_{a2}$ | enthalpy of wet air leaving indoor air-side, J/kg of dry air |
| $h_{k1}$ | enthalpy of steam entering calorimeter evaporator, J/kg |
| $h_{k2}$ | enthalpy of liquid leaving calorimeter evaporator, J/kg |
| $h_{w1}$ | enthalpy of water or steam supplied to humidifier, kJ/kg |
| $h_{w2}$ | enthalpy of condensed moisture leaving calorimeter room, kJ/kg |
| *Re* | Reynolds number |
| $p_n$ | pressure, at nozzle throat, kPa absolute |
| $p_v$ | velocity pressure at nozzle throat or static pressure difference across nozzle, Pa |
| $\phi_i$ | other power input to calorimeter room, W |
| $\phi_E$ | effective power input, W |
| $\phi_{hi}$ | total heating capacity as determined in calorimeter room, W |
| $\phi_{lci}$ | latent cooling capacity, (indoor air-side data), W |
| $\phi_r$ | power input to indoor-side compartment, W |
| $\phi_{li}$ | heat flow through enveloping surfaces of calorimeter room, W |
| $\phi_{lr}$ | heat leakage into calorimeter room, W |
| $\phi_t$ | total power input, W |
| $\phi_{sci}$ | sensible cooling capacity, (indoor air-side data), W |
| $\phi_{sri}$ | sensible reheat capacity, (indoor air-side data), W |
| $\phi_{tci}$ | total cooling capacity, (indoor side data), W |
| $\phi_{tco}$ | total cooling capacity, (liquid-side data), W |
| $\phi_{thi}$ | total heating capacity, (indoor air-side data), W |
| $q_i$ | airflow, indoor, calculated, m$^3$/s |
| $q_{mi}$ | airflow, indoor, measured, m$^3$/s |
| $q_s$ | airflow, standard air, m$^3$/s |
| $t_{a1}$ | temperature, air entering indoor side, dry bulb, °C |
| $t_{a2}$ | temperature, air leaving indoor side, dry bulb, °C |
| $t_{a5}$ | temperature, air leaving reheat coil, dry bulb, °C |
| $t_{f3}$ | temperature, liquid entering equipment, °C |
| $t_{f4}$ | temperature, liquid leaving equipment, °C |
| $V_n$ | velocity of air, at nozzle, m/s |
| $v_{a1}$ | specific volume of air, leaving indoor side, m$^3$/kg of dry air |

| Symbol | Description and units |
|---|---|
| $v_{i1}$ | specific volume of air, entering indoor side, $m^3$/kg of dry air |
| $v_n$ | specific volume of air at conditions existing at nozzle at standard barometric pressure |
| $v'_n$ | specific volume of air at nozzle, $m^3$/kg of air-water vapour mixture |
| $W_{i1}$ | humidity ratio, air entering indoor side, kg/kg of dry air |
| $W_{i2}$ | humidity ratio, air leaving indoor side, kg/kg of dry air |
| $W_n$ | humidity ratio, at nozzle, kg/kg of dry air |
| $w_{a1}$ | mass flow rate, indoor air, kg/s |
| $w_k$ | flow rate, liquid condensate (steam), kg/s |
| $w_r$ | water vapour (rate) condensed by reconditioning equipment, kg/s |
| $w_f$ | mass flow rate, liquid, kg/s |

# Annex H
(informative)

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**ICS 27.080**

**Descriptors:** heat exchangers, heat pumps, ratings, tests, performance tests, testing conditions, marking.

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