ERRATA SHEET FOR
ANSI/ASHRAE STANDARD 37-2009
Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment

February 15, 2012

The corrections listed in this errata sheet apply to ANSI/ASHRAE Standard 37-2009. The first printing of 137-2009 is identified as "Product Code: 86094 9/09" on the outside back cover.

Page	**Erratum**
13	**7.3.3.4.** In Section 7.3.3.4(a) change the SI equation as follows: *(Note: Additions are shown in <u>underline</u> and deletions are shown in ~~strikethrough~~.)* $\underline{\dot{q}_l}$ ~~q_l~~ $= (0.61 + 0.0053D_t^{0.75}\Delta t^{1.25} +$ $\underline{0.0798}$~~79.8~~$D_t\Delta t)L$ $[= (0.63 + 0.03D_t^{0.75}\Delta t^{1.25} + 1.17D_t\Delta t)L]$
13	**7.3.3.4.** In Section 7.3.3.4(b) change the SI equation as follows: *(Note: Additions are shown in <u>underline</u> and deletions are shown in ~~strikethrough~~.)* $\underline{\dot{q}_l}$ ~~q_l~~ $= (0.62 +$ $\underline{0.031}$~~0.31~~$(Th)^{-0.33}D_t^{0.75}\Delta t^{1.25})L$ $[= (0.64 + 0.06(Th)^{-0.33}D_t^{0.75}\Delta t^{1.25})L]$
25	**Table 4 Symbols *(continued)*.** Change "q_l" *to* "$\dot{q}_l$".

ANSI/ASHRAE Standard 37-2009
(Supersedes ANSI/ASHRAE Standard 37-2005)

ASHRAE STANDARD

Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment

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Cognizant TC: TC 8.11, Unitary and Room Air Conditioners and Heat Pumps
SPLS Liaison: Matt R. Hargan

SPECIAL NOTE

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b. participation in the next review of the Standard,
c. offering constructive criticism for improving the Standard, or
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ANSI/ASHRAE Standard 37-2009
Methods of Testing for Rating Electrically Driven Unitary Air-Conditioning and Heat Pump Equipment

NOTE

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FOREWORD

This is a revision of Standard 37-2005. This standard was prepared under the auspices of the American Heating Refrigerating and Air-Conditioning Engineers (ASHRAE). It may be used, in whole or in part, by an association or government agency with due credit to ASHRAE. Adherence is strictly on a voluntary basis and merely in the interests of obtaining uniform standards throughout the industry. This version updates the references section, superscripts references cited in the text and corrects the erratum in section 7.7.2.1.

1. PURPOSE

1.1 The purpose of this standard is to provide test methods for determining the cooling capacity of unitary air-conditioning equipment and the cooling or heating capacities, or both, of unitary heat pump equipment.

1.2 These test methods do not specify methods of establishing ratings that involve factors such as manufacturing tolerances and quality control procedures.

2. SCOPE

2.1 This standard applies to electrically driven mechanical-compression unitary air conditioners and heat pumps consisting of one or more assemblies that include an indoor air coil(s), a compressor(s), and an outdoor coil(s). Where such equipment is provided in more than one assembly, the separated assemblies are designed to be used together.

2.2 This standard does not include methods of testing the following:

(a) cooling coils for separate use
(b) condensing units for separate use
(c) room air conditioners
(d) heat-operated unitary equipment
(e) liquid chilling packages
(f) multiple indoor air coils operating simultaneously in heating and cooling modes

3. DEFINITIONS

air, standard: dry air having a mass density of 1.204 kg/m^3 (0.075 lb/ft^3).

apparatus: as used in this standard, this term refers exclusively to test room facilities and instrumentation.

capacity, heating: the rate, expressed in watts (Btu/h), at which the equipment adds heat to the air passing through it under specified conditions of operation.

capacity, latent cooling: the rate, expressed in watts (Btu/h), at which the equipment removes latent heat from the air passing through it under specified conditions of operation.

capacity, sensible cooling: the rate, expressed in watts (Btu/h), at which the equipment removes sensible heat from the air passing through it under specified conditions of operation.

capacity, total cooling: the rate, expressed in watts (Btu/h), at which the equipment removes heat from the air passing through it under specified conditions of operation.

coil, indoor: the heat exchanger that removes heat from or adds heat to the conditioned space.

coil, outdoor: the heat exchanger that rejects heat to or absorbs heat from a source external to the conditioned space.

equipment: as used in this standard, this term refers exclusively to the unitary equipment to be tested.

equipment, unitary: this term shall be defined as provided in Section 2 and Section 4.

indoor side: that part of the system that removes heat from or adds heat to the indoor airstream.

outdoor side: that part of the system that rejects heat to or absorbs heat from a source external to the indoor airstream.

pressure, standard barometric: 101.325 kPa (14.696 psi).

refrigerant, volatile: a refrigerant that changes from the liquid to the vapor state in the process of absorbing heat.

shall: where “shall” or “shall not” is used for a provision, that provision is mandatory if compliance with the standard is claimed.

should, recommended, or it is recommended**:** “should,” “recommended,” or “it is recommended” are used to indicate provisions that are not mandatory but that are desirable as a good practice.

4. CLASSIFICATIONS

Unitary equipment within the scope of this standard may be classified as follows:

4.1 Component Arrangement:

(a) Units employing compressor(s), indoor air coil(s), and outdoor coil(s) in a single package assembly.
(b) Units employing compressor(s) and indoor coil(s) in one or more assemblies with remote outdoor coil(s).
(c) Units employing indoor coil assemblies, with outdoor coil(s) and compressor(s) in one or more assemblies.

4.2 Method of Outdoor Coil Heat Exchange:

(a) air,
(b) liquid, and
(c) evaporative cooled condensing.

Note: Related Air-Conditioning and Refrigeration Institute (ARI) classifications for unitary air conditioners and heat pumps are given in Tables A-1 and A-2, respectively, in Appendix A, and are illustrative but not restrictive.

5. INSTRUMENTS

5.1 Temperature Measuring Instruments

5.1.1 All temperature measurements (with the exception of dew point temperature) shall be made in accordance with ANSI/ASHRAE Standard 41.1.[1]

5.1.2 If used in determining the water vapor content of the air, dew point hygrometers shall be applied as specified in ANSI/ASHRAE Standard 41.6[2] and shall be accurate to within ±0.2°C (0.4°F).

5.1.3 Inlet air temperature measurements are to be taken upstream of static pressure taps on the inlet duct (if installed). Outlet air temperature measurements shall be taken downstream of the static pressure taps on the outlet.

5.2 Refrigerant, Liquid, and Barometric Pressure Measuring Instruments

5.2.1 Pressure measurements shall be made with one or more of the following instruments:

(a) liquid column
(b) Bourdon tube gauge
(c) electronic pressure transducer

ASHRAE Standard 41.3[3] should be referred to for information on the above instruments.

5.2.2 The accuracy of the pressure measuring instruments shall permit measurements to within ±2.5% of the reading.

5.2.3 Calibration of the pressure measuring instrument shall be with respect to a deadweight tester or by comparison with a liquid column.

5.2.4 In no case shall the smallest scale division of the pressure measuring instrument exceed two times the specified accuracy.

5.3 Air Differential Pressure and Airflow Measurements

5.3.1 The static pressure difference across nozzles and velocity pressures at nozzle throats shall be measured with manometers or electronic pressure transducers that have been calibrated against a pressure standard to within ±1.0% of the reading. The resolution of the device shall be equal to or less than 2.0% of the reading.

5.3.2 Duct static pressure shall be measured with one or more manometers or electronic pressure transducers that are accurate to within ±2.5 Pa (±0.01 in. H_2O).

5.3.3 Areas of nozzles shall be determined by measuring their diameters to within ±0.20% in four places approximately equally spaced around the nozzle in each of two planes through the nozzle throat, one at the outlet and the other in the straight section near the radius.

5.4 Electrical Instruments

5.4.1 Electrical measurements shall be made with indicating or integrating instruments.

5.4.2 Instruments used for measuring the electrical power input to fan motors, compressor motors, or other equipment accessories shall be accurate to within ±2.0% of the reading. ***Note:*** For an efficiency rating purpose, a more accurate measurement of the electrical power input may be required.

5.4.3 Instruments used for measuring the electrical power input to heaters or other apparatus furnishing heat loads (see 7.7.1.2 and Figure 10) shall be accurate to within ±1.0% of the quantity measured.

5.4.4 Voltages shall be measured at the equipment terminals. Instruments used for measuring voltage shall be accurate to within ±1.0% of the reading.

5.5 Volatile Refrigerant Flow Measurement

5.5.1 Volatile refrigerant flow shall be measured with an integrating flow measuring system that is accurate to within ±1.0% of the reading.

5.6 Liquid Flow Measurement

5.6.1 Water and brine flow rates shall be measured with a liquid flow meter or quantity meter that is accurate to within ±1.0% of the reading.

5.6.2 Condensate collection rates shall be determined using a liquid quantity meter that is accurate to within ±1.0% of the reading.

5.7 Speed Measuring Instruments

5.7.1 Speed measurements shall be made with a revolution counter, tachometer, stroboscope, or oscilloscope that is accurate to within ±1.0% of the reading.

5.8 Time and Mass Measurements

5.8.1 Time interval measurements shall be made with an instrument that is accurate to within ±0.2% of the reading.

5.8.2 Mass measurements shall be made with an apparatus that is accurate to within ±1.0% of the reading.

5.9 Volatile refrigerant mass composition measurements for zeotropic refrigerants shall be made using an instrument that is in accordance with ARI Standard 700-95.[4]

6. AIRFLOW AND AIR DIFFERENTIAL PRESSURE MEASUREMENT APPARATUS

6.1 Enthalpy Apparatus. Recommended configurations for the test apparatus are provided below. In all cases, suitable means for determining the dry-bulb temperature and water vapor content of the air entering and leaving the unit and for measuring the external resistance to airflow shall be provided.

6.1.1 The arrangement for the tunnel air-enthalpy method is shown schematically in Figure 1. An airflow measuring device is attached to the equipment air discharge (indoor or outdoor, or both, 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.

6.1.2 An arrangement for a typical loop air-enthalpy method is illustrated in Figure 2. The unit is installed as it would be for the tunnel arrangement. The airflow measuring device discharge is connected to suitable reconditioning equipment that is, in turn, connected to the equipment inlet. The resulting closed 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 and wet-bulb temperatures of the air surrounding the equipment shall be maintained to within ±3°C (±5°F) of the specified indoor and outdoor conditions.

6.1.3 The arrangement for the calorimeter air-enthalpy method is pictured 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 shall be nonhygroscopic and should be airtight and 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 15 cm (6 in.) 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 airflow measuring device is connected to the equipment discharge. Dry-bulb temperature and water vapor content of the air entering the equipment are to be determined at the enclosure inlet.

6.1.4 The room air enthalpy method arrangement is shown in Figure 4. An airflow measuring device is attached to the equipment air discharge (evaporator or condenser, as applicable) and then, in turn, connected to suitable reconditioning equipment. The discharge from the reconditioning apparatus provides air to the test room at the desired dry-bulb temperature and water vapor content.

6.1.5 The arrangements shown in Figures 1, 2, 3, and 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 3 must be used when the compressor is in the indoor section and separately ventilated.

6.1.6 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 prescribed means of measuring airflow rate, temperature, and external resistance and provided that they do not create abnormal conditions surrounding the equipment.

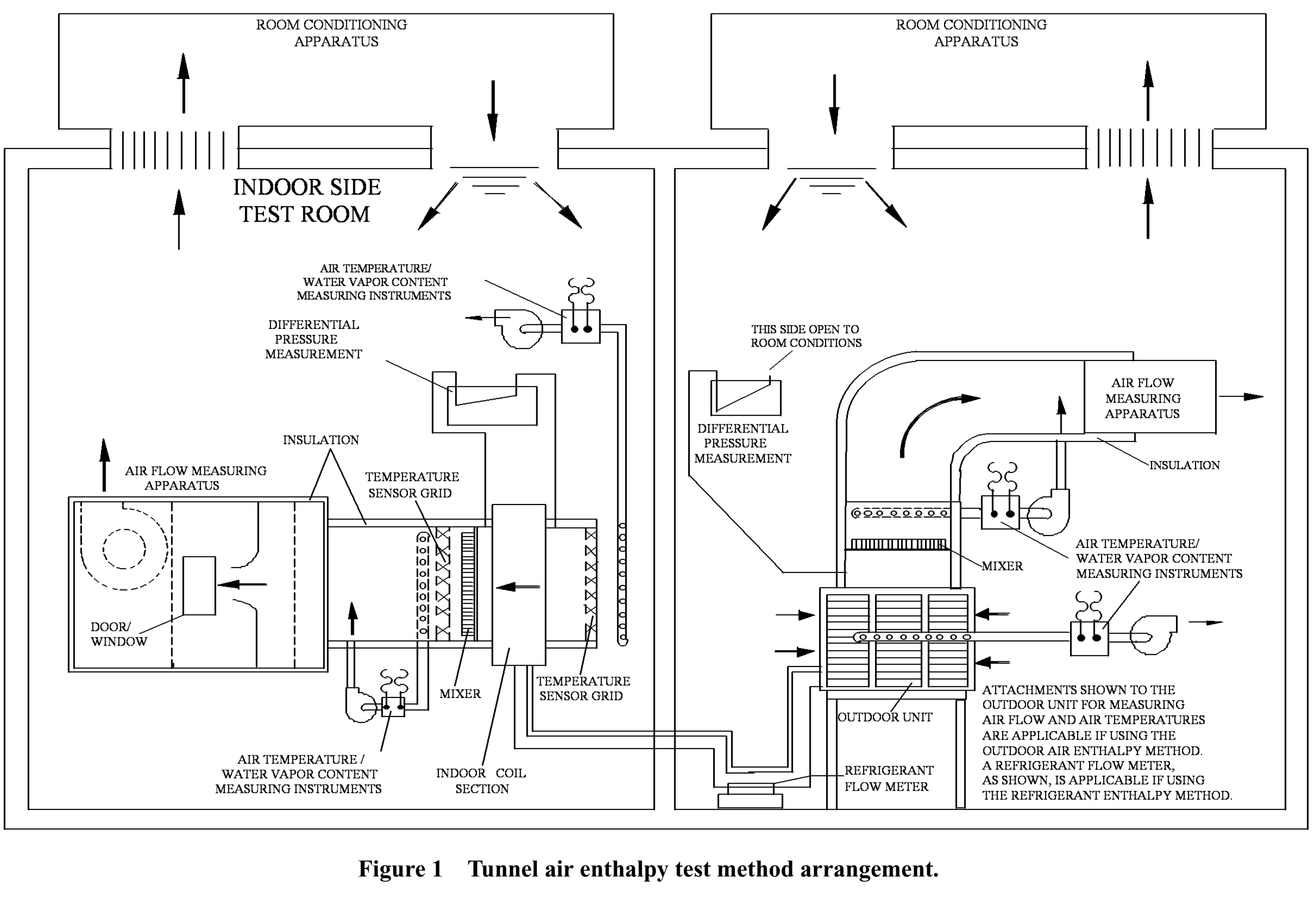

Figure 1 Tunnel air enthalpy test method arrangement.

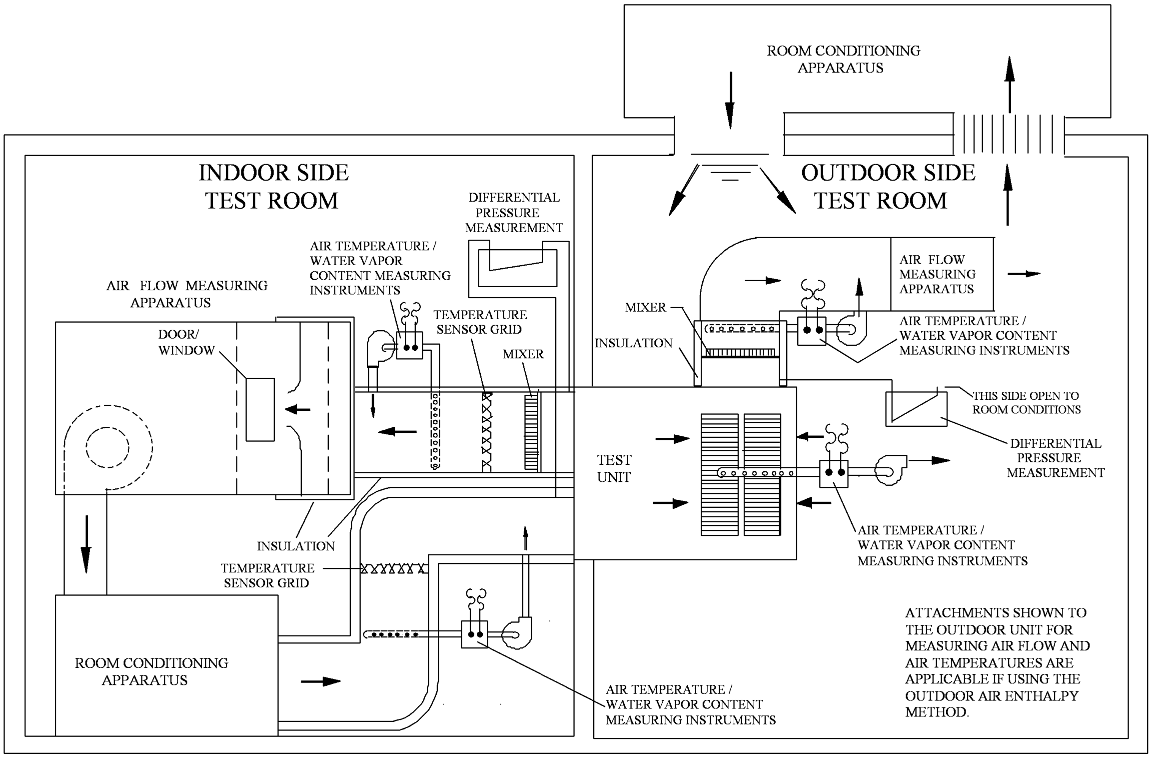

Figure 2 Loop air enthalpy test method arrangement.

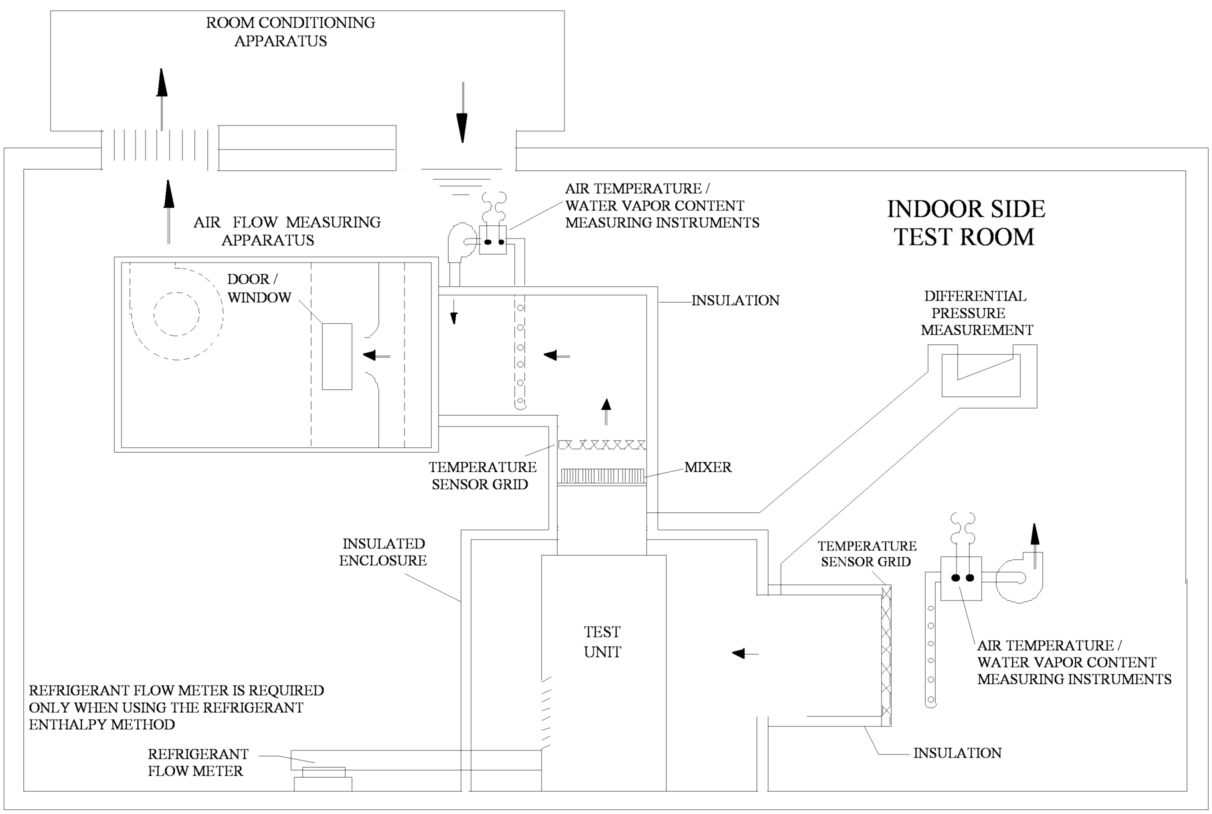

Figure 3 Calorimeter air enthalpy test method arrangement.

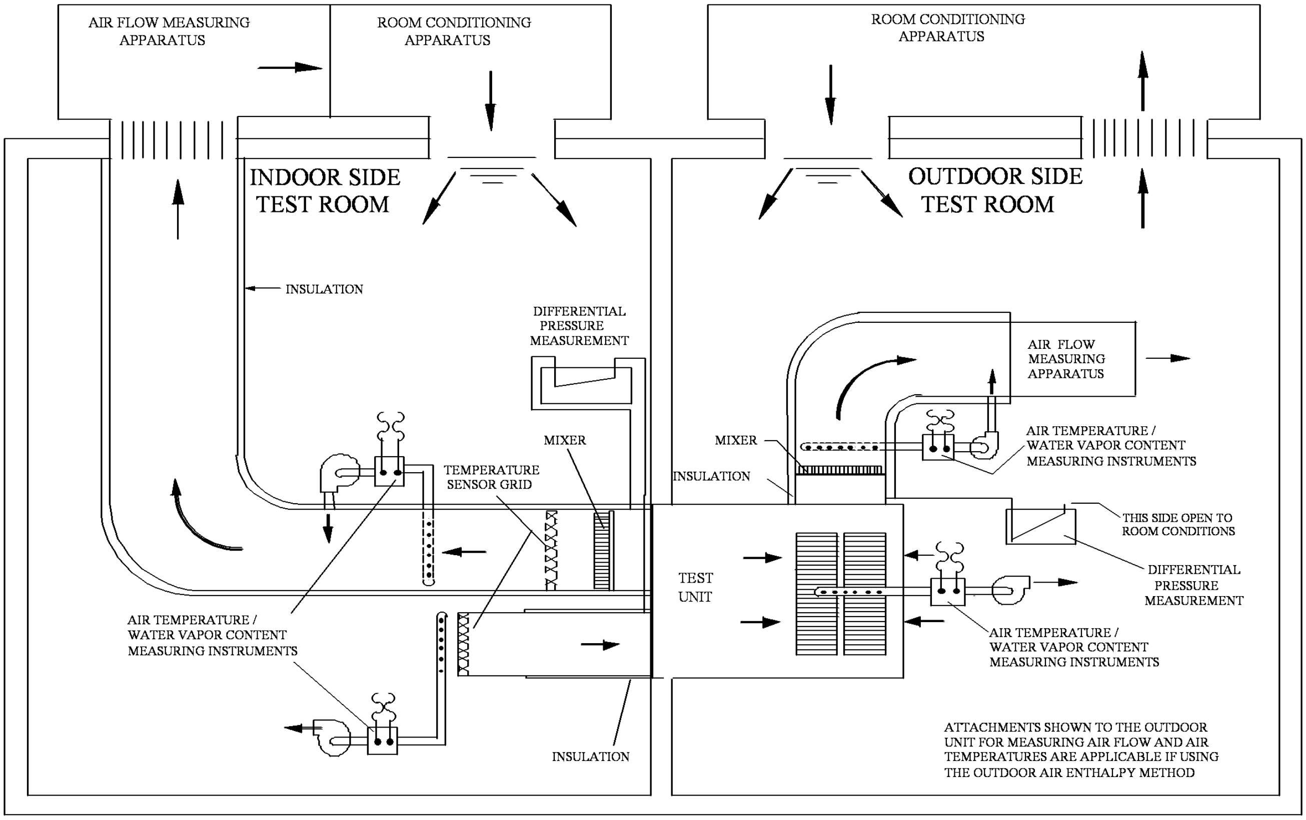

Figure 4 Room air enthalpy test method arrangement.

6.2 Nozzle Airflow Measuring Apparatus

6.2.1 As shown in Figure 5, the nozzle airflow measuring apparatus basically consists of a receiving chamber and a discharge chamber separated by a partition in which one or more nozzles are located. Air from the equipment under test is conveyed via duct to the receiving chamber, passes through the nozzle or nozzles, and is then exhausted to the test room or channeled to the reconditioning equipment.

6.2.2 The nozzle airflow measuring apparatus and its connections to the equipment outlet shall be sealed so that air leakage does not exceed 1.0% of the airflow rate being measured.

6.2.3 The center-to-center distance between nozzles in use shall be not less than three times the throat diameter of the largest nozzle, and the distance from the center of any nozzle to the nearest discharge or receiving chamber side wall shall be not less than 1.5 times its throat diameter.

6.2.4 Diffusers shall be installed in the receiving chamber located at least 1.5 times the largest nozzle throat diameter upstream of the partition wall. Diffusers in the discharge chamber shall be located at least 2.5 times the largest nozzle throat diameter downstream of the exit plane of the largest nozzle.

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

6.2.6 The static pressure drop across the nozzle or nozzles shall be measured with a manometer or an electronic pressure transducer. One side of the pressure measuring device shall be connected to four manifolded pressure taps installed within the receiving chamber. The other side of the pressure measuring device shall be connected to four manifolded pressure taps installed within the discharge chamber. Alternatively, the velocity head of the airstream leaving the nozzle or nozzles may be measured by a pitot tube as shown in Figure 5, but when more than one nozzle is in use, the pitot tube reading shall be determined for each nozzle.

6.2.7 Recommendations on how to fabricate and manifold the static pressure taps, if used in measuring air volume rate, are provided in 6.5. Guidance on the placement of the static pressure taps and the position of the diffusion baffle relative to the receiving chamber inlet is provided in Figure 12 of ANSI/ASHRAE Standard 51.[5]

6.2.8 Means shall be provided to determine the air density at the nozzle throat.

6.3 Nozzles

6.3.1 The throat air velocity of any nozzle in use shall be not less than 15 m/s (3000 fpm) or more than 35 m/s (7000 fpm).

6.3.2 When nozzles are constructed in accordance with Figure 6 and installed in accordance with 6.2 and 6.3, they may be used without calibration. If the throat diameter is 25 cm (10 in.) or larger, the coefficient of discharge (C) may

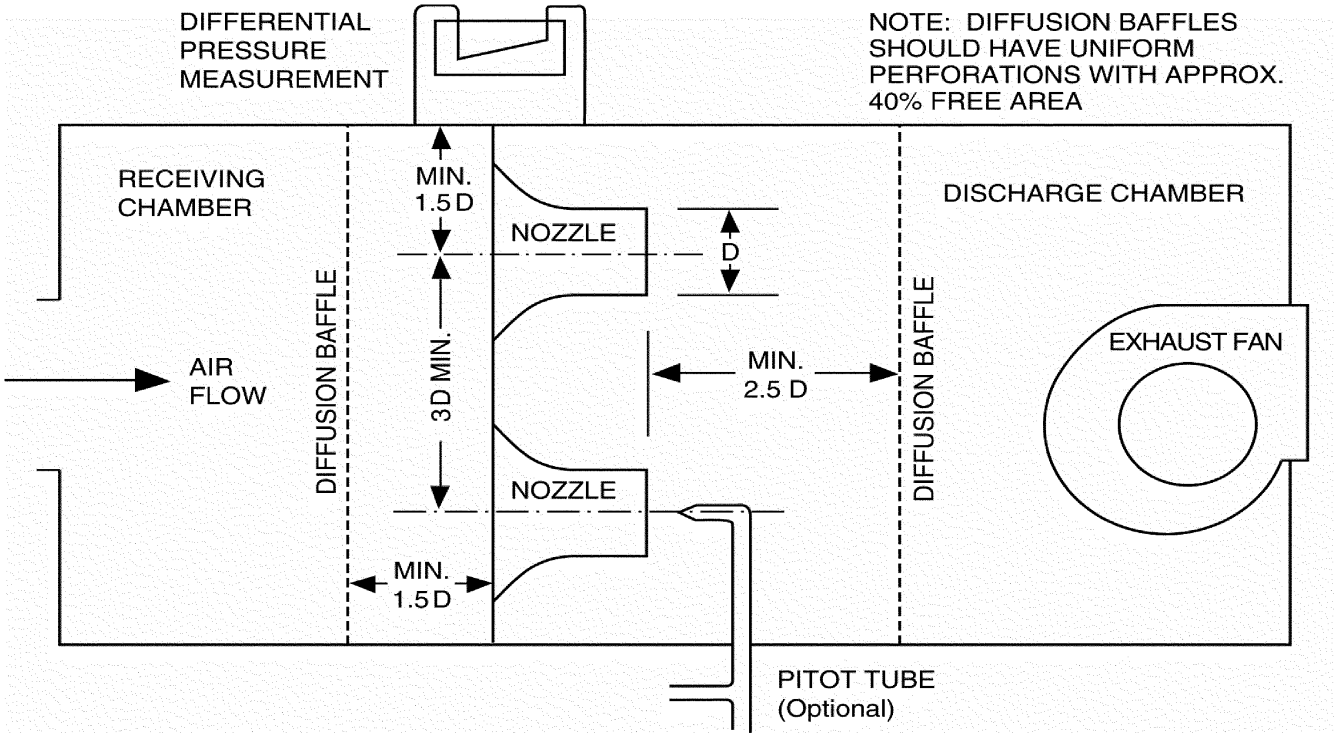

Figure 5 Nozzle airflow measuring apparatus.

be assumed to be 0.99. For nozzles smaller than 25 cm (10 in.) in diameter, the values calculated as specified in 6.3.3 may be used. Additional information and guidance on evaluating the coefficient of discharge is provided in ANSI/ASHRAE Standard 51.[5] (Appendix F of ANSI/ASHRAE Standard 51, for example, shows the iterative procedure for evaluating the coefficient of discharge.) Where a more precise coefficient is desired, the nozzle should be calibrated.

6.3.3 For airflow nozzles having a throat length to throat diameter ratio of 0.6 (see Figure 6), the nozzle default coefficient of discharge shall be calculated as follows:[6]

$$C = 0.9986 - \frac{7.006}{\sqrt{\mathrm{Re}}} + \frac{134.6}{\mathrm{Re}}$$

For Reynolds numbers (Re) of 12,000 and above, the Reynolds number is calculated as follows:

$$\mathrm{Re} = \left(\frac{1}{1000}\right)\frac{DV}{\mu v_n'} = \left(\frac{1}{1000}\right)\frac{D}{\mu v_n'}\left(C\sqrt{2P_v v_n'}\right)$$

$$= \left(\frac{\sqrt{2}}{1000}\right)\frac{D}{\mu}\left(C\sqrt{\frac{P_v(1+W_n)}{v_n}}\right)$$

where V is expressed in units of m/s and D in units of mm.

$$\left[\mathrm{Re} = \left(\frac{1}{60 * 12}\right)\frac{DV}{\mu v_n'} = \left(\frac{1}{720}\right)\frac{D}{\mu v_n'}\left(775.9C\sqrt{2P_v v_n'}\right)\right.$$

$$= \left(\frac{1097}{720}\right)\frac{D}{\mu}\left(C\sqrt{\frac{P_v(1+W_n)}{v_n}}\right)$$

where V is expressed in units of ft/min and D in units of inches.]

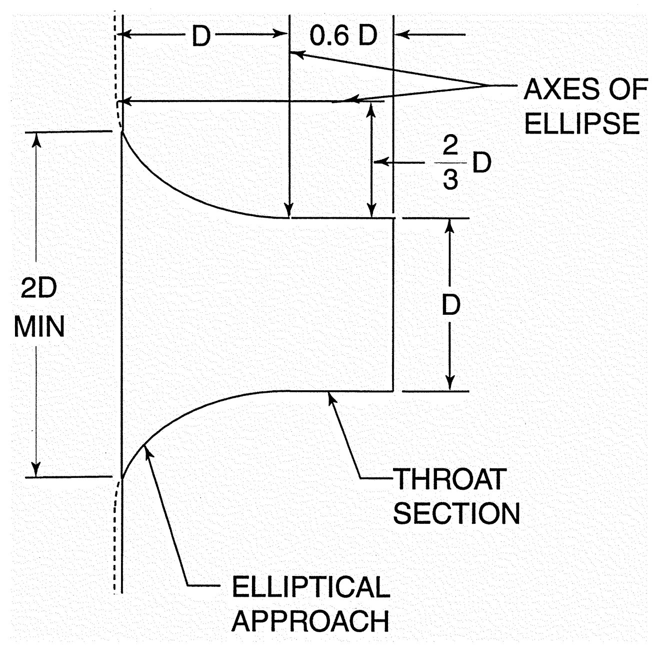

Figure 6 Construction of a nozzle.

The dynamic viscosity (μ) of gaseous air behaving as an ideal gas at moderate pressures and temperatures is calculated using the following equation:

$$\mu = (17.23 + 0.048 t_a) \times 10^{-6}$$

where μ is expressed in kg/m·s and t_a in °C.

$$\left[\mu = (11.00 + 0.018 t_a) \times 10^{-6}\right.$$

where μ is expressed in lbm/ft · s and t_a in °F.]

6.4 External Static Pressure Measurements

6.4.1 General

6.4.1.1 External static pressure shall be measured by a manometer or an electronic pressure transducer.

6.4.1.2 Static pressure taps, where used, should be fabricated and manifolded as described in 6.5.

6.4.2 Units with a Fan and a Single Outlet

6.4.2.1 Where an external static pressure measurement is required, a short plenum chamber shall be attached to the outlet of the discharge side of the equipment. This plenum shall have cross-sectional dimensions equal to the dimensions of the equipment outlet and shall discharge into an airflow measuring device (or into a suitable dampening device when a direct airflow measurement is not employed, see 7.2.2). One side of the pressure measuring device shall be connected to four manifolded pressure taps in the discharge plenum. These taps shall be positioned a distance of twice the mean geometric cross-sectional dimension from the equipment outlet, as shown in Figure 7a.

6.4.2.2 If space within the test room permits, an inlet duct connection should be installed. If used, the inlet duct shall have cross-sectional dimensions equal to those of the equipment and should otherwise be fabricated as shown by the setups given in Figures 7b and 7c. One side of the pressure measuring device described in 6.4.2.1 shall be connected to four manifolded pressure taps installed within the inlet duct. If no inlet duct connection is employed, however, one side of the pressure measuring device described in 6.4.2.1 shall be open to the surrounding atmosphere.

6.4.3 Units with Fans and Multiple Outlets and/or Multi-Evaporators

6.4.3.1 Units with multiple discharge outlet duct connections or multi-evaporator systems shall have a short plenum conforming to Figure 7a attached to each outlet. Each plenum shall discharge into a single common duct section. If air volume rate is to be measured directly, then this duct section shall discharge into an airflow measuring device. For the purpose of equalizing the static pressure in each plenum, an adjustable restrictor shall be located in the plane where each plenum enters the common duct section. External static pressure in each plenum shall be measured as specified in 6.4.2. Multiple blower units employing a single discharge duct connection flange shall be tested with a single outlet duct in accordance with 6.4.2. Any other test plenum arrangements shall not be used except to simulate duct designs specifically recommended by the equipment manufacturer.

6.4.4 Units without a Fan

6.4.4.1 For indoor coil sections that do not incorporate a fan, the inlet and outlet duct connections shall have cross-sectional dimensions equal to the duct flanges of the supplied or recommended coil enclosure.

6.4.4.2 The air static pressure drop shall be measured as shown in Figure 8. One side of the pressure measuring device shall be connected to four manifolded pressure taps in the outlet duct with the other side of the pressure measuring device being connected to four manifolded pressure taps in the inlet.

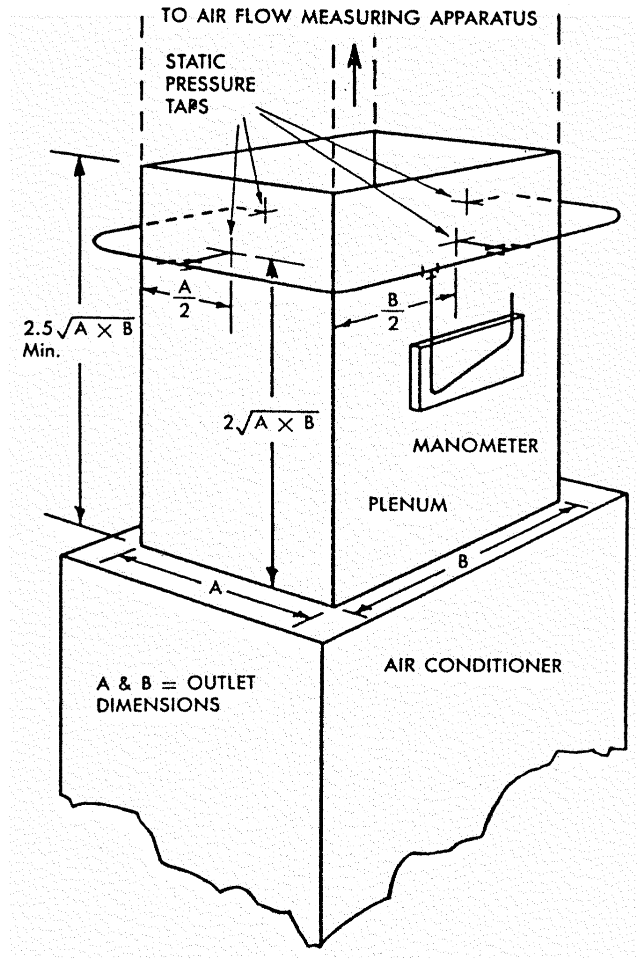

Figure 7a External static pressure measurement.

Note: The following statements apply to Figures 7 and 8.

For circular ducts, substitute $\pi D_i^2/4$ for C × D and $\pi D_o^2/4$ for A × B.

The length of the inlet duct, $1.5\sqrt{C \times D}$, is a minimum dimension. For more precise results, use $4\sqrt{C \times D}$.

The inlet and outlet taps shall be installed relative to the coil inlet and outlet, respectively, as shown in Figure 8.

6.5 Recommended Practices for Static Pressure Measurements

6.5.1 A tap should be located at the center of each face of each plenum, if rectangular, or at four evenly distributed locations along the perimeter of an oval or round plenum.

6.5.2 It is recommended that the pressure taps consist of 6.25 mm (0.25 in.) diameter nipples soldered to the outer plenum surfaces and centered over 1 mm (0.040 in.) diameter holes through the plenum. The edges of these holes should be free of burrs and other surface irregularities.

6.5.3 Static pressure taps should be manifolded using one of the two recommended connection options shown in Figure 9.

6.6 Duct Insulation and Sealing Requirements

6.6.1 The plenum(s) and duct section(s) shall be sealed to prevent air leakage, particularly at the connections to the

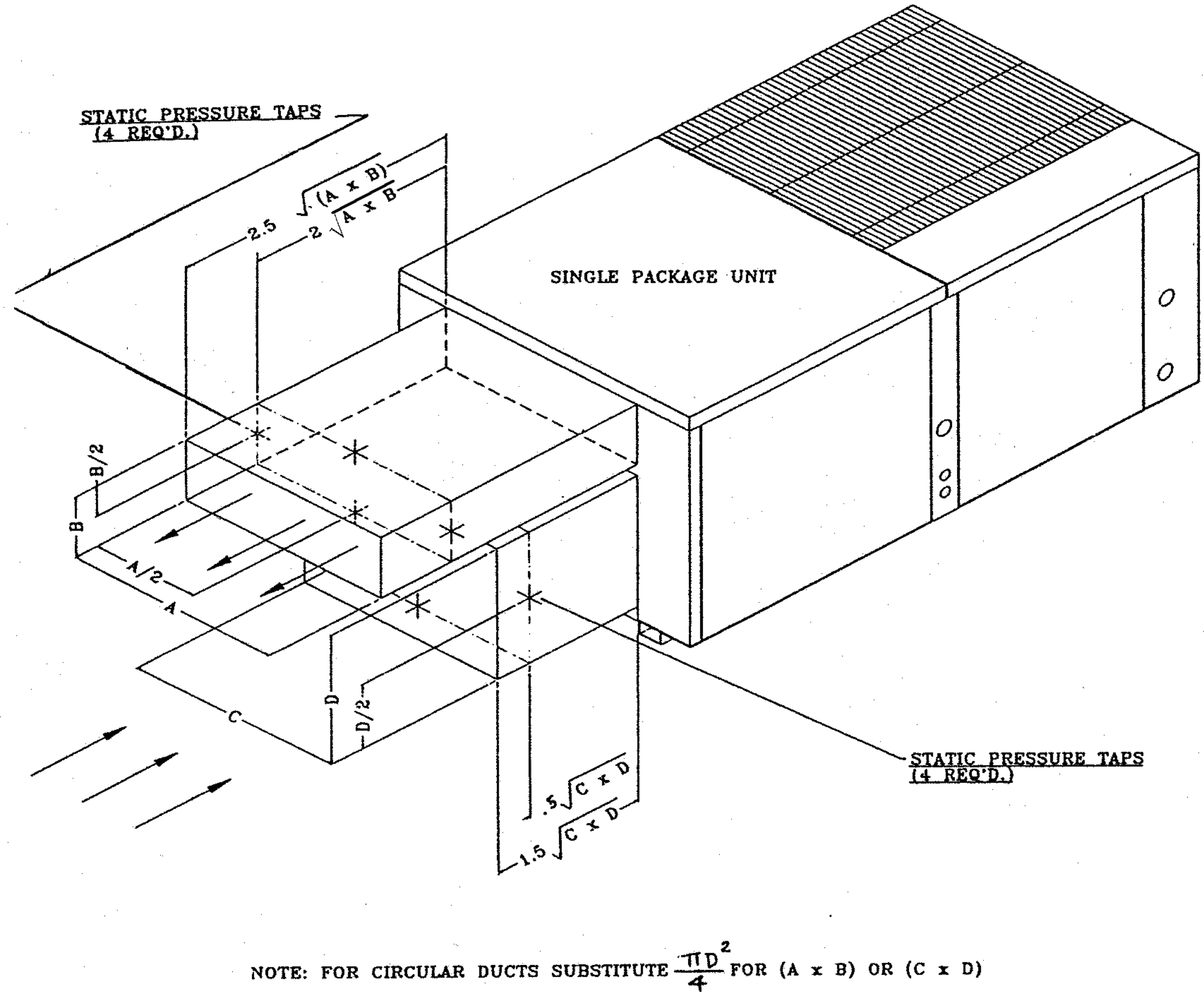

Figure 7b External static pressure measurement.

equipment and the airflow measuring device. The plenum(s) and the duct section(s) shall be insulated to minimize heat leakage between the equipment inlet or outlet and the temperature measuring instruments. Duct losses may be calculated using suitable conduction factors, inside air and outside ambient temperature difference, and the total duct surface area between the unit and the temperature measurement location.

7. METHODS OF TESTING AND CALCULATION

7.1 Standard Test Methods. The following five test methods for measuring space conditioning capacity are covered in this standard:

(a) Indoor air enthalpy method (see 7.3)
(b) Outdoor air enthalpy method (see 7.3)
(c) Compressor calibration method (see 7.4)
(d) Refrigerant enthalpy method (see 7.5)
(e) Outdoor liquid coil method (see 7.6)

In addition, an alternative to the method described in 6.2 and 6.3 for measuring indoor airflow rate is described in 7.7. Section 7.8 describes a method for measuring cooling condensate and determining latent cooling capacity. Use of 7.7 and 7.8 is not required except when testing equipment having a rated cooling capacity of 40 kW (135,000 Btu/h) or greater where the indoor air enthalpy method is not used.

7.2 Applicability of Test Methods

7.2.1 Simultaneous tests using the indoor air enthalpy method (Group A in Table 1) and one other applicable method from Group B in Table 1 shall be conducted when testing equipment rated as having a total cooling capacity that is less than 40 kW (135,000 Btu/h).

7.2.2 When testing equipment rated as having a total cooling capacity of 40 kW (135,000 Btu/h) or greater, at least one of the applicable methods from Table 1, Group A or Group B, except the Outdoor Air Enthalpy Method, shall be used. For cases where an air-source heat pump is to be tested and one or more heating capacity tests in the defrost region are to be conducted (see 8.8), the indoor air enthalpy method must be used. When the indoor air enthalpy method is not used, indoor airflow rate shall be determined from the space conditioning capacity test using the indirect method described in 7.7.1.2

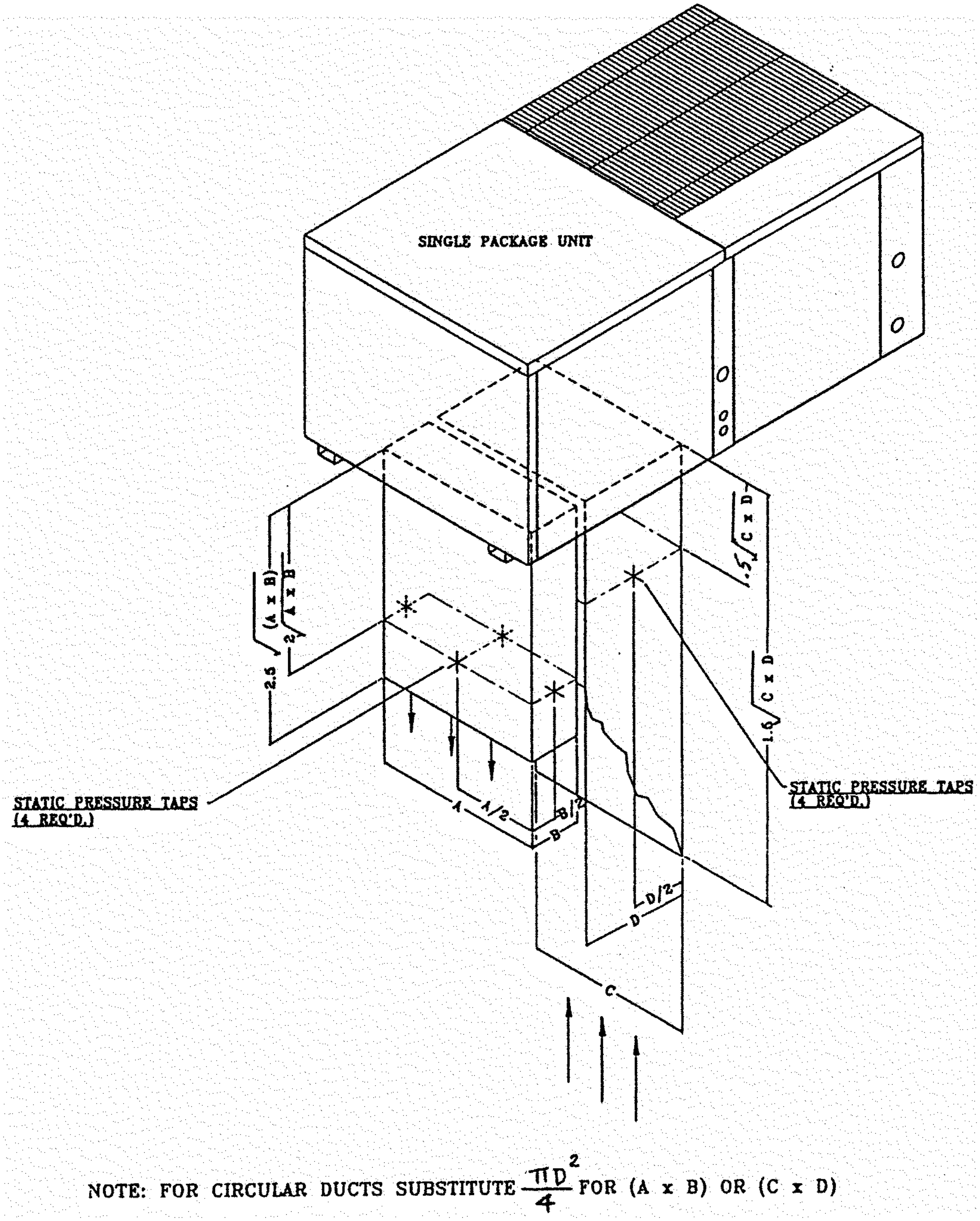

Figure 7c External static pressure measurement.

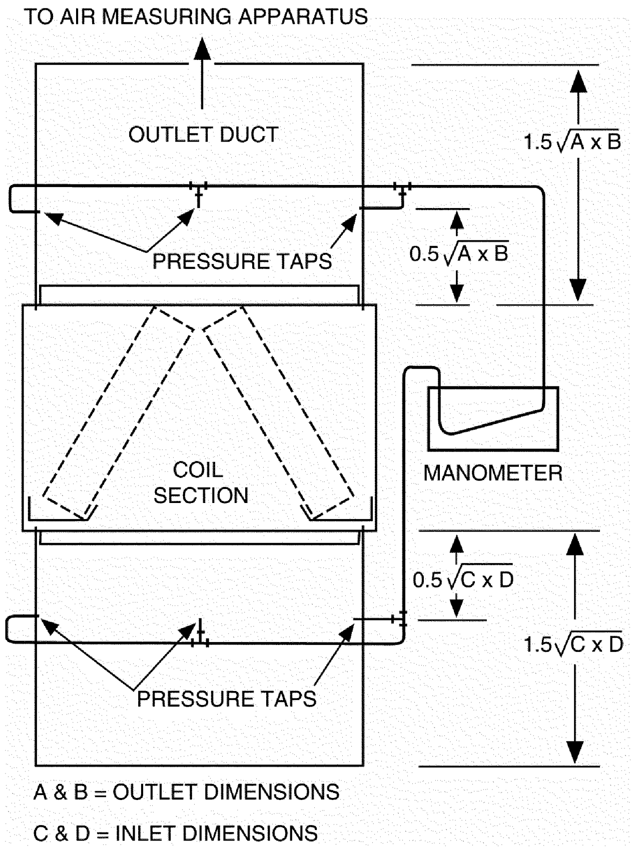

Figure 8 Air static pressure drop measurement for coil (without fan).

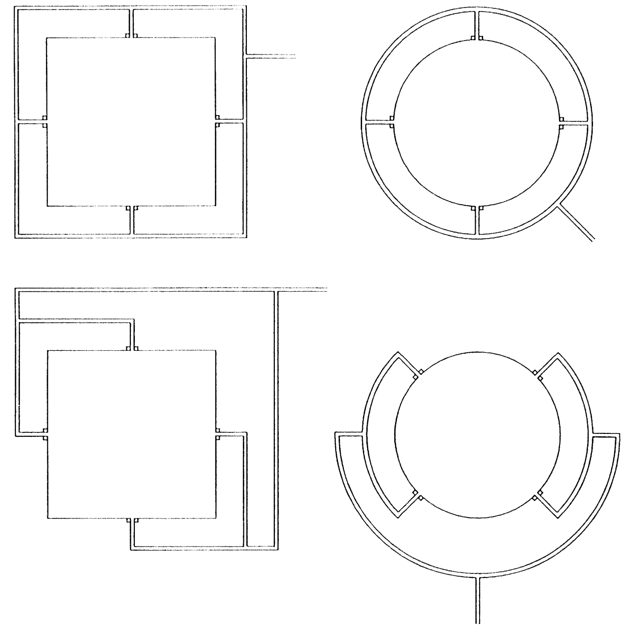

Figure 9 Recommended connection options for static pressure taps.

and 7.7.3 and, for cooling tests, latent cooling capacity shall be determined by measuring condensate as described in 7.8.

7.2.3 The methods described in this standard may be used to test unitary equipment not covered in Table 1. However, proper consideration must be given in the capacity calculations to adhere to energy balance principles.

7.3 Indoor and Outdoor Air Enthalpy Methods

7.3.1 Space conditioning capacity is determined by measuring airflow rate and the dry-bulb temperature and water vapor content of the air that enters and leaves the coil. Air enthalpies shall be determined in accordance with ANSI/ASHRAE Standard 41.6.[2]

7.3.2 The outdoor air enthalpy method may be used when testing air cooled equipment that is rated as having a total cooling capacity less than 40 kW (135,000 Btu/h) and that does not use remote liquid chillers. Use of this method, however, is subject to the additional requirements and apparatus arrangement limitations specified in 8.6 and, if the equipment uses a remote outdoor coil(s), to the line loss adjustments described in 7.3.3.4 and 7.3.4.4.

7.3.3 Cooling Calculations

7.3.3.1 Total, sensible, and latent indoor cooling capacities, based on test data collected according to the indoor air enthalpy method, shall be calculated using the following equations (see note below):

$$q_{tci} = \frac{Q_{mi}(h_{a1} - h_{a2})}{v_n} = \frac{Q_{mi}(h_{a1} - h_{a2})}{v'_n(1 + W_n)}$$

$$\left[= \frac{60Q_{mi}(h_{a1} - h_{a2})}{v_n} = \frac{60Q_{mi}(h_{a1} - h_{a2})}{v'_n(1 + W_n)}\right]$$

$$q_{sci} = \frac{Q_{mi}(c_{p_{a1}} t_{a1} - c_{p_{a2}} t_{a2})}{v_n} = \frac{Q_{mi}(c_{p_{a1}} t_{a1} - c_{p_{a2}} t_{a2})}{v'_n(1 + W_n)}$$

$$\left[= \frac{60Q_{mi}(c_{p_{a1}} t_{a1} - c_{p_{a2}} t_{a2})}{v_n} = \frac{60Q_{mi}(c_{p_{a1}} t_{a1} - c_{p_{a2}} t_{a2})}{v'_n(1 + W_n)}\right]$$

where

$$c_{p_{a1}} = 1005 + 1805 W_1$$

$$[= 0.24 + 0.444 W_1]$$

$$c_{p_{a2}} = 1005 + 1805 W_2$$

$$[= 0.24 + 0.444 W_2]$$

and

Note: the latent indoor cooling capacity is a function of the latent heat of vaporization (h_{fg}) of water; in 7.3.3.1 equations for q_{lci}, the h_{fg} corresponding to 13°C (57°F) is used: 2.47×10^6 J/kg (1061 Btu/lbm). Also, the energy associated with the leaving condensate is not included because its impact on net capacity is negligible.

TABLE 1 Applicable Test Methods

Section Reference		Group A[a,b]	Group B[a,b]				
		7.3	7.3	7.4	7.5	7.6	7.7 & 7.8
Equipment component arrangement(s)	Method of heat rejection during cooling cycle	Indoor air enthalpy method	Outdoor air enthalpy method[c,d]	Compressor calibration method[e]	Refrigerant enthalpy method[e,f]	Outdoor liquid coil method[g]	Cooling condensate and indirect airflow measurement
Single package unit	Air cooled	X	X	X[h]			X
	Evaporatively cooled	X		X[h]			X
	Water cooled	X		X[h]		X	X
Remote outdoor heat exchanger; compressor within conditioned space	Air cooled	X	X	X[h]	X[h]		X
	Evaporatively cooled	X		X[h]	X[h]		X
	Water cooled	X		X[h]	X[h]	X	X
Remote outdoor heat exchanger and compressor	Air cooled	X	X	X	X		X
	Evaporatively cooled	X		X	X		X
	Water cooled	X		X	X		X
Remote outdoor heat exchanger; remote compressor within space	Air cooled	X	X	X[h]	X[h]		X
	Evaporatively cooled	X		X[h]	X[h]		X
	Water cooled	X		X[h]	X[h]	X	X

a For equipment having a rated cooling capacity less than 40 kW (135,000 Btu/h), capacity shall be determined using the indoor air enthalpy method and, except as noted in 8.8.3, using one of the applicable methods from Group B.
b For equipment having a rated cooling capacity of 40 kW (135,000 Btu/h) and greater, at least one prescribed method from Group A or Group B (with the exception of the outdoor air enthalpy method [see 7.3.2]) is required. For cases where the indoor airflow rate is not directly measured, and/or the indoor air enthalpy method is not used, the requirements specified in 7.2.2 shall be invoked.
c Applicable only for equipment having a rated cooling capacity less than 40 kW (135,000 Btu/h).
d Test subject to 8.6.
e Not applicable for cooling capacity tests if the cooling mode expansion device is located remotely from the indoor coil(s).
f Test subject to 7.5.1 and 7.5.2.
g Test subject to 7.6.1.2. Not applicable if compressor is ventilated by outdoor air.
h Not applicable if uninsulated outdoor water coil is located in the indoor airstream, or if compressor is uninsulated and is ventilated by indoor air.

$$q_{lci} = 2.47 \times 10^6 \frac{Q_{mi}(W_1 - W_2)}{v_n} = 2.47 \times 10^6 \frac{Q_{mi}(W_1 - W_2)}{v'_n(1 + W_n)}$$

$$\left[= (1061)(60)\frac{Q_{mi}(W_1 - W_2)}{v_n} = (1061)(60)\frac{Q_{mi}(W_1 - W_2)}{v'_n(1 + W_n)} \right]$$

7.3.3.2 Total indoor cooling capacity based on test data collected according to the outdoor air enthalpy method shall be calculated using one of the following equations:

$$q_{tco} = \frac{Q_{mo}(h_{a4} - h_{a3})}{v_n} - E_t = \frac{Q_{mo}(h_{a4} - h_{a3})}{v'_n(1 + W_n)} - E_t$$

$$\left[= \frac{60Q_{mo}(h_{a4} - h_{a3})}{v_n} - 3.41E_t = \frac{60Q_{mo}(h_{a4} - h_{a3})}{v'_n(1 + W_n)} - 3.41E_t \right]$$

or for air-cooled equipment that does not re-evaporate drained condensate from the indoor coil,

$$q_{tco} = \frac{Q_{mo}c_{p_{a4}}(t_{a4} - t_{a3})}{v_n} - E_t = \frac{Q_{mo}c_{p_{a4}}(t_{a4} - t_{a3})}{v'_n(1 + W_n)} - E_t$$

$$\left[= \frac{60Q_{mo}c_{p_{a4}}(t_{a4} - t_{a3})}{v_n} - 3.41E_t = \frac{60Q_{mo}c_{p_{a4}}(t_{a4} - t_{a3})}{v'_n(1 + W_n)} - 3.41E_t \right]$$

where

$$c_{p_{a4}} = 1005 + 1805W_4$$

$$[= 0.24 + 0.444W_4]$$

7.3.3.3 When the indoor or outdoor air enthalpy method is used, the total and sensible cooling capacities shall be adjusted for duct losses. The duct loss adjustment shall be added to the total and sensible cooling capacities. The duct loss adjustment shall be calculated as follows:

If using the indoor air enthalpy test method and the equipment indoor section is located in the indoor test room, then

$$(q_{loss})_{IA} = (UA_{duct})_{2i}(t_{ai} - t_{a2}) .$$

If using the outdoor air enthalpy method and the equipment outdoor section is located in the outdoor test room, then

$$(q_{loss})_{OA} = (UA_{duct})_{4o}(t_{a4} - t_{ao}) .$$

If using the indoor air enthalpy test method and the equipment indoor section is located in an outdoor test room, then

$$(q_{loss})_{IA} = (UA_{duct})_{1o}(t_{ao} - t_{a1}) + (UA_{duct})_{2o}(t_{ao} - t_{a2}) + (UA_{duct})_{2i}(t_{ai} - t_{a2}) .$$

7.3.3.4 A line loss capacity adjustment shall be applied if using the outdoor air enthalpy method as the secondary method and if the adjustment is needed to obtain the energy balance specified in 10.1.2 (for equipment having a rated cooling capacity less than 40 kW [135,000 Btu/h]). The line loss capacity adjustment shall be added algebraically to the capacity determined using the outdoor air enthalpy method, q_{tco}. The adjustment shall be evaluated as follows:

(a) For bare copper tube,

$$q_l = (0.61 + 0.0053 D_t^{0.75} \Delta t^{1.25} + 79.8 D_t \Delta t) L$$

$$[= (0.63 + 0.03 D_t^{0.75} \Delta t^{1.25} + 1.17 D_t \Delta t) L]$$

(b) For insulated lines,

$$q_l = (0.62 + 0.31 (Th)^{-0.33} D_t^{0.75} \Delta t^{1.25}) L$$

$$[= (0.64 + 0.06 (Th)^{-0.33} D_t^{0.75} \Delta t^{1.25}) L]$$

The temperature difference Δt is defined as the difference between the average refrigerant temperature and the surrounding ambient temperature.

7.3.4 Heating Calculations When Using the "S" Test Method of Section 8.8.2

7.3.4.1 The total heating capacity based test data collected according to the indoor air enthalpy method shall be calculated using the following equation:

$$q_{thi} = \frac{Q_{mi} c_{p_{a2}} (t_{a2} - t_{a1})}{v_n} = \frac{Q_{mi} c_{p_{a2}} (t_{a2} - t_{a1})}{v'_n (1 + W_n)}$$

$$\left[= \frac{60 Q_{mi} c_{p_{a2}} (t_{a2} - t_{a1})}{v_n} = \frac{60 Q_{mi} c_{p_{a2}} (t_{a2} - t_{a1})}{v'_n (1 + W_n)} \right]$$

where $c_{p_{a2}}$ is calculated as specified in Section 7.3.3.1 and

$$W_n = W_1 = W_2$$

7.3.4.2 The total heating capacity based on test data collected as described in the outdoor air enthalpy method shall be calculated using

$$q_{tho} = \frac{Q_{mo}(h_{a3} - h_{a4})}{v_n} + E_t = \frac{Q_{mo}(h_{a3} - h_{a4})}{v'_n (1 + W_n)} + E_t$$

$$\left[= \frac{60 Q_{mo}(h_{a3} - h_{a4})}{v_n} + 3.41 E_t = \frac{60 Q_{mo}(h_{a3} - h_{a4})}{v'_n (1 + W_n)} + 3.41 E_t \right]$$

where

$$W_n = W_4$$

7.3.4.3 When the indoor or outdoor air enthalpy method is used, the total heating capacity shall be adjusted for the duct losses. The duct loss adjustment shall be calculated as specified in 7.3.3.3 and then subtracted algebraically (i.e., subtract q_{loss} if it is positive and add q_{loss} if it is negative) from the heating capacity determined using the indoor or outdoor air enthalpy method.

7.3.4.4 A line loss capacity adjustment shall be applied if using the outdoor air enthalpy method as the secondary method and if the adjustment is needed to obtain the energy balance specified in 10.1.2 (for equipment having a rated cooling capacity less than 40 kW [135,000 Btu/h]). The line loss capacity adjustment specified in 7.3.3.4 shall be subtracted algebraically (i.e., subtract the q_l's that are positive and add the q_l's that are negative) from the capacity determined using the outdoor air enthalpy method, q_{tho}.

7.3.5 Heating Calculations When Using the "T" Test Method of Section 8.8.3

7.3.5.1 For equipment in which defrosting occurs, an average heating capacity corresponding to the total number of complete cycles shall be determined. If a defrost does not occur during the data collection interval, an average heating capacity shall be determined using data from the entire interval.

7.3.5.2 Average space heating capacity shall be determined as follows:

$$q_{thi} = \frac{Q_{mi} c_{p_{a2}} \Gamma}{(\tau_2 - \tau_1) v_n} = \frac{Q_{mi} c_{p_{a2}} \Gamma}{(\tau_2 - \tau_1)(v'_n (1 + W_n))}$$

$$\left[= \frac{60 Q_{mi} c_{p_{a2}} \Gamma}{(\tau_2 - \tau_1) v_n} = \frac{60 Q_{mi} c_{p_{a2}} \Gamma}{(\tau_2 - \tau_1)(v'_n (1 + W_n))} \right]$$

where $c_{p_{a2}}$ is calculated as specified in Section 7.3.3.1,

$$W_n = W_1 = W_2 ,$$

and

$$\Gamma = \int_{\tau_1}^{\tau_2} (t_{a2}(\tau) - t_{a1}(\tau)) \delta\tau .$$

For heat pumps that automatically cycle off the indoor fan during a defrost cycle, the quantity $t_{a2}(\tau) - t_{a1}(\tau)$ shall be assigned as zero during the off interval. The elapsed time while the indoor fan is off shall be included as part of the total test time (i.e., $\tau_2 - \tau_1$) that is used for evaluating average heating capacity.

7.4 Compressor Calibration Method

7.4.1 General Description

7.4.1.1 For the compressor calibration method, total cooling capacity or heating capacity is determined as follows:

(a) For cases where the superheat of the refrigerant leaving the evaporator is 3°C (5°F) or higher, capacity shall be evaluated by determining refrigerant flow rate and the change in refrigerant enthalpy between the inlet and outlet of the indoor section or indoor side of the equipment. Refrigerant flow rate shall be deduced based on prior or subsequent calibration of the compressor under identical operating conditions: the same compressor suction and discharge pressures and the same compressor suction temperature. As described in Section 6 of ASHRAE Standard 23,[7] compressor calibration may be achieved using either one of the calorimeter methods or one of the flow meter methods.

(b) For cooling mode tests where the superheat of the refrigerant leaving the evaporator is less than 3°C (5°F), cooling capacity shall be determined by conducting a separate evaporator-type calorimeter test where the compressor is operated under the same test conditions as encountered for the equipment test.

(c) For heating mode tests where the superheat of the refrigerant leaving the evaporator is less than 3ºC (5ºF), heating capacity shall be determined as described above in (a) with the additional stipulation that refrigerant flow rate shall be deduced based on compressor calibrations conducted using a condenser-type calorimeter.

7.4.2 Refrigerant Properties Measurement

7.4.2.1 With the equipment operating at the desired test conditions, the temperature and pressure of the refrigerant leaving the indoor section or side, entering the indoor section or side (heating mode), entering the expansion device (cooling mode), and entering and leaving the compressor shall be measured. For cases where the indoor air enthalpy method is also conducted, data used to calculate capacity according to the compressor calibration method and the indoor air enthalpy method shall be collected over the same intervals.

7.4.2.2 On equipment not sensitive to refrigerant charge, pressure measuring instruments may be tapped into the refrigerant lines provided that they do not affect the total charge by more than 0.5%.

7.4.2.3 On equipment sensitive to refrigerant charge, a preliminary test is required prior to connecting any pressure gauges or beginning the first official test. In preparation for this preliminary test, temperature sensors shall be attached to the equipment's indoor and outdoor coils. The sensors shall be located at points that are not affected by vapor superheat or liquid subcooling. Placement near the midpoint of the coil, at a return bend, is recommended. The preliminary test shall be conducted as described in 8.7 with the additional requirement that the temperatures of the on-coil sensors be included with the regularly recorded data. After the preliminary test is completed, the refrigerant shall be removed from the equipment, and the needed pressure gauges shall be installed. The equipment shall be evacuated and recharged with refrigerant. The test shall then be repeated. Once steady-state operation is achieved, refrigerant shall be added or removed until, as compared to the average values from the preliminary test, the following conditions are achieved: (1) each on-coil temperature sensor indicates a reading that is within ±0.3°C (0.5°F), (2) the temperatures of the refrigerant entering and leaving the compressor are within ±2°C (3°F), and (3) the refrigerant temperature entering the expansion device is within ±0.5°C (1.0°F). Once these conditions have been achieved over an interval of at least ten minutes, refrigerant charging equipment shall be removed and the first of the official tests shall be initiated.

7.4.2.4 Refrigerant temperatures shall be measured by means of thermocouples or equivalent devices that are properly attached to the lines at appropriate locations.

7.4.2.5 No instrumentation shall be removed, replaced, or otherwise disturbed during any portion of a complete capacity test.

7.4.2.6 Temperatures and pressures of the refrigerant vapor entering and leaving the compressor shall be measured at approximately 25 cm (10 in.) from the compressor shell. If the reversing valve is included in the calibration, these measurements should be taken on the lines to the coils at approximately 25 cm (10 in.) from the reversing valve.

7.4.3 Compressor Flow Rate Calibration

7.4.3.1 Refrigerant flow rate shall be determined based on separate calibration tests conducted on the same compressor as used by the equipment under test. For cases where the superheat of the refrigerant leaving the evaporator is 3°C (5°F) or higher, the calibration tests shall be conducted using one of the applicable methods specified in ASHRAE Standard 23.[7] For cases where the equipment is heating and the refrigerant superheat leaving the evaporator is less than 3°C (5°F), however, the condenser calorimeter method described in ASHRAE Standard 23[7] and ANSI/ASHRAE Standard 41.9[8] shall be exclusively used to determine refrigerant flow rate. Refrigerant flow rate calibration tests are not applicable for cases where the equipment is cooling and the refrigerant superheat leaving the evaporator is less than 3°C (5°F) (see 7.4.4 instead).

7.4.3.2 Calibration tests shall be performed with the compressor and reversing valve (where used) at the same ambient temperature and air pattern as in the tested equipment.

7.4.4 Cooling Capacity Secondary Test for Equipment, When Tested, Having a Suction Superheat Less than 3°C (5°F)

7.4.4.1 For cooling mode tests where the superheat of the refrigerant leaving any evaporator is less than 3ºC (5ºF), a separate test using an evaporator-type calorimeter shall be conducted. The three evaporator-type calorimeters that may be used are:

1. Secondary refrigerant calorimeter
2. Secondary fluid calorimeter
3. Primary refrigerant calorimeter

The separate calorimeter test shall be conducted as specified in ASHRAE Standard 23[7] and ANSI/ASHRAE Standard 41.9.[8] For these particular calorimeter tests, adherence to the requirements given in Sections 7.2.2.3, 7.2.2.5, 8.2.2.3, 8.2.2.5, 9.2.2.3, and 9.2.2.5 of ANSI/ASHRAE Standard 41.9[8] shall be waived.

7.4.4.2 In order to conduct the follow-up calorimeter test, knowledge of the following parameters from the original equipment test are required: the evaporator saturation temperature or pressure and refrigerant temperature leaving the evaporator. The condenser saturation temperature or pressure from the original equipment test should also be recorded.

7.4.4.3 Using the results from the evaporator-type calorimeter test, total cooling capacity shall be calculated as specified in 7.4.5.2.

7.4.5 Compressor Calibration Method Calculations—Cooling Capacity When the Equipment Suction Superheat Is 3°C (5°F) or Higher

7.4.5.1 For tests in which the evaporator superheat is 3°C (5°F) or higher, total cooling capacity shall be calculated as follows:

$$q_{tc} = w_r(h_{r2} - h_{r1}) - E_i$$

$$[= w_r(h_{r2} - h_{r1}) - 3.41E_i]$$

where h_{r2}, h_{r1}, and E_i are measured during the equipment test, and w_r is determined based on prior or subsequent compressor calibration tests and refrigerant property measurements made during the equipment test.

7.4.5.2 For tests in which the evaporator superheat is less than 3°C (5°F), total cooling capacity shall be calculated as follows:

$$q_{tc} = q_e + UA_a(t_a - t_c) - E_i$$

$$[= q_e + UA_a(t_a - t_c) - 3.41E_i]$$

where E_i is measured during the original equipment test while q_e, UA_a, t_a, and t_c are all measured during the subsequent evaporator-type calorimeter test described in 7.4.4.

7.4.6 Compressor Calibration Method Calculations—Heating Capacity

7.4.6.1 Total heating capacity shall be calculated as follows:

$$q_{th} = w_r(h_{r1} - h_{r2}) + E_i$$

$$[= w_r(h_{r1} - h_{r2}) + 3.41E_i]$$

where h_{r1}, h_{r2}, and E_i are measured during the equipment test, and w_r is determined based on prior or subsequent compressor calibration tests and refrigerant property measurements made during the equipment test.

7.5 Refrigerant Enthalpy Method

7.5.1 General Description

7.5.1.1 In this method, capacity is determined from the refrigerant enthalpy change and flow rate. Enthalpy changes are determined from measurements of entering and leaving pressures and temperatures of the refrigerant, and the flow rate is determined by a suitable flow meter in the liquid line. With the equipment operating at the desired test conditions, the temperature and pressure of the refrigerant leaving the indoor section or side and either entering the indoor section or side (heating mode) or entering the expansion device (cooling mode) shall be measured. For cases where the indoor air enthalpy method is also conducted, data used to calculate capacity as described in the refrigerant enthalpy method and the indoor air enthalpy method shall be collected over the same intervals.

7.5.1.2 This method may be used for tests of equipment in which the refrigerant charge is not critical and where normal installation procedures involve the field connection of refrigerant lines.

7.5.1.3 This method shall not be used for tests in which the refrigerant liquid leaving the flow meter is subcooled less than 2°C (3°F) or for tests in which any instantaneous measurement of the superheat of the vapor leaving the indoor section is less than 3°C (5°F).

7.5.2 Refrigerant Flow Measurement

7.5.2.1 The refrigerant flow rate shall be measured with an integrating type flow meter connected in the liquid line upstream of the refrigerant control device. This meter shall be sized so that its pressure drop does not exceed the vapor pressure change that a 2°C (3°F) saturation temperature change would produce.

7.5.2.2 Temperature and pressure measuring instruments and a sight glass shall be installed immediately downstream of the meter to determine if the refrigerant liquid is adequately subcooled. Subcooling of 2°C (3°F) and the absence of any vapor bubbles in the liquid are considered adequate. It is recommended that the meter be installed at the bottom of a vertical downward loop in the liquid line to take advantage of the static head of liquid thus provided.

7.5.2.3 At the end of the test, a sample of the circulating refrigerant and oil mixture should be taken from the equipment and the percentage of oil measured in accordance with ANSI/ASHRAE Standard 41.4.[9] The total indicated flow rate should then be corrected for the amount of circulating oil, especially if the refrigerant enthalpy method is being used as the secondary method and the flow adjustment is needed to comply with 10.1.2.

7.5.2.4 For systems using zeotropic refrigerants, a sample of the superheated vapor refrigerant should be removed while the unit is running in order to conduct a composition analysis. The refrigerant properties should be adjusted based on the measured composition using an established refrigerant property database. Such adjustments should be made especially if the refrigerant enthalpy method is being used as the secondary method and compliance with 10.1.2 is not otherwise achieved.

7.5.3 Refrigerant Temperature and Pressure Measurement

7.5.3.1 The temperature and pressure of the refrigerant entering and leaving the indoor side of the equipment shall be measured with instruments in accordance with Section 5.

7.5.4 Refrigerant Enthalpy Method Calculations—Cooling Capacity

7.5.4.1 Total cooling capacity shall be calculated as follows:

$$q_{tci} = x\rho V_{ro}(h_{r2} - h_{r1}) - E_i = xw_{ro}(h_{r2} - h_{r1}) - E_i$$

$$[= x\rho V_{ro}(h_{r2} - h_{r1}) - 3.41E_i = xw_{ro}(h_{r2} - h_{r1}) - 3.41E_i]$$

7.5.5 Refrigerant Enthalpy Method Calculations—Heating Capacity

7.5.5.1 Total heating capacity shall be calculated as follows:

$$q_{thi} = x\rho V_{ro}(h_{r1} - h_{r2}) + E_i = xw_{ro}(h_{r1} - h_{r2}) + E_i$$

$$[= x\rho V_{ro}(h_{r1} - h_{r2}) + 3.41E_i = xw_{ro}(h_{r1} - h_{r2}) + 3.41E_i]$$

7.6 Outdoor Liquid Coil Method

7.6.1 General Description

7.6.1.1 In this method, total cooling or heating capacity is determined from measurements of the outdoor coil liquid temperature change and flow rate.

7.6.1.2 This method may be used for the test of equipment that uses a liquid (e.g., water) as a heat sink or source. The method may be used for factory-assembled packaged equipment. The method may also be used to test equipment with a remote outdoor coil if the remote coil is insulated or if the manufacturer recommends insulating the coil with the equivalent of not less than 25 mm (1.0 in.) of glass fibrous insulation. This method may only be used where the compressor is ventilated in the indoor airstream or is in an indoor closed compartment that is not ventilated or is insulated in the same manner as described above for the outdoor coil.

7.6.2 Liquid Flow Rate Measurement

7.6.2.1 The outdoor coil liquid flow rate shall be measured with a liquid quantity or flow meter in accordance with 5.6.

7.6.3 Temperature Measurement

7.6.3.1 Entering and leaving liquid temperatures shall be measured with instruments in accordance with 5.1.1 at the equipment connections.

7.6.4 Outdoor Liquid Coil Method Calculations—Cooling Capacity

7.6.4.1 Total cooling capacity shall be calculated as follows:

$$q_{tco} = w_l c_{p_l}(t_{l4} - t_{l3}) - E_t$$

$$[= w_l c_{p_l}(t_{l4} - t_{l3}) - 3.41E_t]$$

7.6.5 Outdoor Liquid Coil Method Calculations—Heating Capacity

7.6.5.1 Total heating capacity shall be calculated as follows:

$$q_{tho} = w_l c_{p_l}(t_{l3} - t_{l4}) - E_t$$

$$[= w_l c_{p_l}(t_{l3} - t_{l4}) - 3.41E_t]$$

7.6.6 Pump Power Considerations

7.6.6.1 The total power input term, E_t, in the equations above (in Sections 7.6.4.1 and 7.6.5.1) shall include the measured power input to the pump only if the pump is located between the inlet and outlet water temperature sensors, i.e., between t_{l3} and t_{l4}.

7.6.7 Interconnecting Tubing Adjustment

7.6.7.1 For equipment with a remote outdoor coil, allowance shall be made in the capacity calculations for heat gains or losses through the interconnecting tubing (see 7.3.3.4.).

7.7 Airflow Rate Measurement

7.7.1 Measurement Methods—According to Rated Cooling Capacity

7.7.1.1 For equipment having a rated cooling capacity less than 40 kW (135,000 Btu/h), the indoor airflow rate shall be measured using the nozzle airflow measuring apparatus described in 6.2 and pictured in Figure 5. The apparatus may also be used to measure the airflow rate through the outdoor coil, which is needed, for example, if using the outdoor air enthalpy method to provide the secondary capacity measurement.

The airflow nozzle(s) that is used shall be selected and applied in accordance with 6.3 and Figure 6. The airflow rate shall be calculated as specified in 7.7.2. Figure 12 of ANSI/ASHRAE Standard 51[5] should be referred to for guidance on the placement of the static pressure taps and the position of the diffusion baffle (settling means) relative to the chamber inlet. Deviations from the specified test setup shall be allowed only if such deviations are described in ANSI/ASHRAE Standard 51.[5]

7.7.1.2 For equipment having a rated capacity of 40 kW (135,000 Btu/h) or higher, the indoor airflow rate may be measured as described in 7.7.1.1. For cases where a Section 6.2 nozzle airflow measuring apparatus is not used and capacity is determined using one or more of the below listed test methods, airflow rate shall be determined indirectly. Indirect determination shall be achieved by using the calculated capacity or by measuring the dry-bulb temperature and water vapor content of the air that enters and leaves the indoor coil (see 7.7.3).

(a) Compressor calibration method
(b) Refrigerant enthalpy method
(c) Outdoor liquid coil method

As a third option, airflow rate may be determined using the modified airflow measurement apparatus shown in Figure 10. For this third option, the airstream is heated by a measurable amount and the increase in air dry-bulb temperature is measured. The modified airflow measurement apparatus is located downstream of the static pressure taps, the dry-bulb temperature sensors, and the instrumentation used in determining the water vapor content of the outlet air. Airflow rate shall be calculated as specified in 7.7.4 when the modified airflow measurement apparatus is used.

7.7.2 Calculations—Nozzle Airflow Measuring Apparatus

7.7.2.1 The airflow rate through a single nozzle is calculated by the following equations:

$$Q_{mi} = CA_n\sqrt{2P_V v'_n}$$

$$[= 775.9CA_n\sqrt{2P_V v'_n} = 1097CA_n\sqrt{P_V v'_n}]$$

where

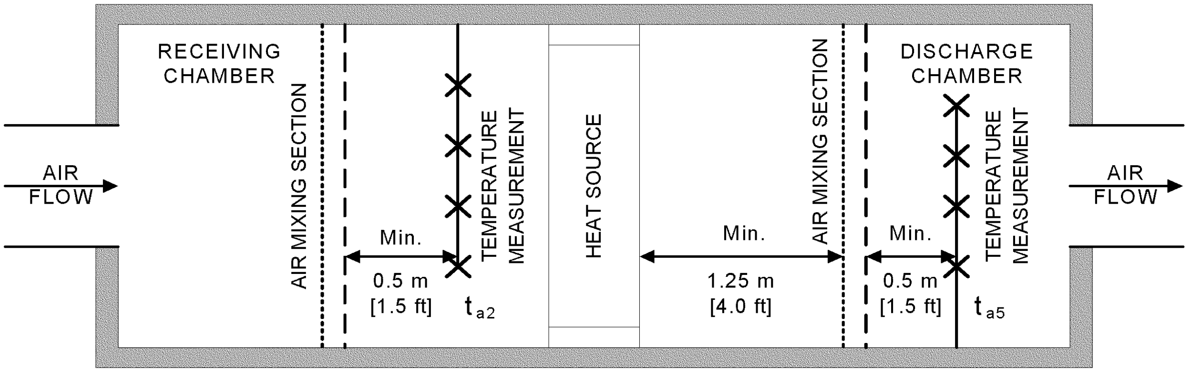

Figure 10 Modified airflow measurement apparatus.

Notes for Figure 10:

1. Air mixing and temperature measurement shall be in accordance with ANSI/ASHRAE Standard 41.1.[1]
2. Heat loss from the enclosure shall be less than 1.0% of the heat input to the heat source.
3. Minimum temperature rise ($t_{a5} - t_{a2}$) across the heat source shall be 10°C (18°F).

$$v'_n = \frac{v_n}{1+W_n} = \frac{101.325 v_{nsp}}{P_n(1+W_n)}$$

$$\left[= \frac{v_n}{1+W_n} = \frac{29.92 v_{nsp}}{P_n(1+W_n)}\right]$$

7.7.2.2 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 7.7.2.1.

7.7.2.3 Airflow rate, expressed in terms of standard air, shall be calculated as follows:

$$Q_s = \frac{Q_{mi}}{1.204 v_n} = \frac{Q_{mi}}{1.204 v'_n(1+W_n)}$$

$$\left[= \frac{Q_{mi}}{0.075 v_n} = \frac{Q_{mi}}{0.075 v'_n(1+W_n)}\right]$$

7.7.3 Calculations—Indirect Determination of Airflow Rate

7.7.3.1 When airflow rate is determined indirectly in accordance with 7.7.1.2, then airflow rate shall be evaluated using the following equations:

For Cooling:

$$Q_i = \frac{q_{tci} v_1}{h_{a1} - h_{a2}}$$

$$\left[= \frac{q_{tci} v_1}{60(h_{a1} - h_{a2})}\right]$$

For Heating:

$$Q_i = \frac{q_{thi} v_1}{h_{a2} - h_{a1}}$$

$$\left[= \frac{q_{thi} v_1}{60(h_{a2} - h_{a1})}\right]$$

7.7.3.2 Airflow rate, expressed in terms of standard air (Q_s), shall be calculated as specified in 7.7.2.3, where v_n and W_n shall be evaluated based on the indoor coil entering air property measurements, i.e., assume $v_n = v_1$ and $W_n = W_1$.

7.7.4 Calculations—Modified Airflow Measurement Apparatus

7.7.4.1 When the modified airflow measurement apparatus described in 7.7.1.2 is used, airflow rate shall be calculated as follows:

$$Q_i = w_{ai} v_{ai}$$

$$\left[= \frac{w_{ai} v_{ai}}{60}\right]$$

where

$$w_{ai} = \frac{q_{sri}}{(1005 + 1805 W_2)(t_{a5} - t_{a2})}$$

$$\left[= \frac{q_{sri}}{(0.24 + 0.444 W_2)(t_{a5} - t_{a2})}\right]$$

The rate of energy added to the air, q_{sri}, shall be determined as follows:

(a) If electric reheat is used:

$$q_{sri} = \text{power input to heater(s)}$$
$$[= \text{power input to heater(s)} \times 3.41]$$

(b) If steam coil reheat is used:

$$q_{sri} = w_k(h_{k1} - h_{k2})$$

7.7.4.2 Airflow rate, expressed in terms of standard air, shall be calculated as follows:

$$Q_s = \frac{Q_i}{1.204 v_{ai}} = \frac{w_{ai}}{1.204}$$

$$\left[= \frac{Q_i}{0.075(60) v_{ai}} = \frac{w_{ai}}{4.5}\right]$$

7.8 Cooling Condensate Measurement

7.8.1 For equipment whose indoor airflow rate is determined indirectly in accordance with 7.7.1.2 and 7.7.3 during cooling mode tests, the latent cooling capacity of the equipment shall be determined from measurements of the condensate flow rate. The drain connection should be trapped to stabilize condensate flow.

7.8.2 Calculations

7.8.2.1 Latent cooling capacity shall be calculated as follows:

$$q_{lci} = 2.47 \times 10^6 \, w_c$$

$$[= 1061 \, w_c]$$

7.8.2.2 The sensible cooling capacity is then calculated as follows:

$$q_{sci} = q_{tci} - q_{lci}$$

where q_{tco} or q_{tc} may be substituted for q_{tci} (refrigerant enthalpy method) if capacity is determined using either the outdoor liquid coil method or the compressor calibration method.

8. TEST PROCEDURES

8.1 Test Room Requirements

8.1.1 Either one or two test rooms are required, depending upon the type of equipment to be tested and the manufacturer's installation instructions.

8.1.2 An indoor condition test room is always required. This may be any room or space in which the desired test conditions can be maintained within the prescribed tolerances. It is recommended that air velocities in the vicinity of the equipment under test do not exceed 2.5 m/s (500 fpm).

8.1.3 An outdoor condition test room or space is required for tests of air and evaporatively cooled equipment and for tests of remote water-cooled equipment. This test room shall be of sufficient volume and shall circulate air in a manner such that it does not change the normal air circulating pattern of the equipment under test. It shall be of dimensions such that the distance from any room surface to any equipment surface from which air is discharged is not less than 1.8 m (6 ft) and the distance from any other room surface to any other equipment surface is not less than 0.9 m (3 ft), except for floor or wall relationships required for normal equipment installation. The room conditioning apparatus should handle air at a rate not less than the outdoor airflow rate and preferably should take this air from the direction of the equipment air discharge and return it at the desired conditions uniformly and at low velocities.

8.2 Equipment Installation

8.2.1 The equipment to be tested shall be installed in the test room(s) in accordance with the manufacturer's installation instructions. Equipment that is intended to be installed indoors shall be located entirely within the indoor test room; equipment that is intended to be installed outdoors shall be located entirely within the outdoor test room. Single-packaged, air-source equipment shall be located in or adjacent to an opening in the wall or partition separating the test rooms in accordance with the normal or primary recommendations of the manufacturer. In all cases, the manufacturer's recommendations with respect to distances from adjacent walls, amount of extensions through walls, etc., shall be followed.

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

8.2.3 Where necessary, equipment shall be evacuated and charged with the type and amount of refrigerant specified in the manufacturer's published instructions.

8.2.4 Interconnecting tubing shall be as furnished or prescribed by the manufacturer. In the absence of other instructions, 7.5 m (25 ft) of tubing should be employed, at least 3 m (10 ft) of which is located in the outdoor test room.

8.2.5 If pressure measuring instruments are used, they shall be connected to the equipment only through short lengths of small diameter tubing and shall be located so that the readings are not influenced by fluid head in the tubing.

8.2.6 No change shall be made in fan speed or system resistance to correct for barometric variations.

8.2.7 For equipment in which the compressor is ventilated independently of the outdoor airstream, the calorimeter air enthalpy arrangement (see Figure 3) must be employed to account for compressor shell heat losses.

8.3 Airflow Measurements

8.3.1 The airflow measuring device shall provide measurements in accordance with the provisions of 7.7.

8.4 External Resistance Measurement

8.4.1 External resistances shall be measured in accordance with the provisions of Section 6.4. Connections to equipment outlets shall comply with the provisions of 6.4.

8.5 Temperature Measurement

8.5.1 Temperature measurements shall be made in accordance with ANSI/ASHRAE Standard 41.1.[1]

8.5.2 In-duct, outlet temperature and water vapor content measurements shall be taken at not less than three locations at the centers of equal segments of the cross-sectional area, or suitable sampling or mixing devices giving equivalent results shall be provided. Typical mixing and sampling devices are illustrated in ANSI/ASHRAE Standard 41.1.[1] Connections to the equipment shall 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.

8.5.3 Indoor inlet dry-bulb temperature and water vapor content measurements shall be taken at not less than three positions equally spaced over the equipment inlet area, or equivalent sampling means provided. For units without an inlet duct connection or enclosure, the dry-bulb temperature and water vapor content measuring instruments or sampling devices should be located approximately 15 cm (6 in.) from the equipment inlet opening or openings.

8.5.4 Outdoor inlet air dry-bulb temperature and water vapor content shall be measured at locations such that the following conditions are fulfilled:

(a) The measured dry-bulb temperature and water vapor content shall be representative of the conditions surrounding the outdoor section and simulate the conditions encountered in an actual application.

(b) At the point of measurement, the psychrometric properties of the air must not be affected by the air discharged from the outdoor section. This makes it mandatory that the air property measurements be made upstream of any recirculation produced. It is intended that the ambient conditions surrounding the outdoor section under test shall simulate as nearly as possible a normal installation operating at ambient air conditions identical with the specified test conditions.

8.5.5 Wet-bulb measurements shall be corrected in accordance with ANSI/ASHRAE Standard 41.1.[1]

8.6 Additional Requirements for the Outdoor Air Enthalpy Method

8.6.1 When the outdoor air enthalpy method is employed, it is necessary to ascertain whether the attachment of the outdoor-side test apparatus (i.e., outlet duct, instrumentation, mixing devices, and the nozzle airflow measuring apparatus [see 6.2]) changes the performance of the equipment being tested and, if so, to correct for this change. To accomplish this, the equipment shall have temperature measuring devices attached to return bends at approximately the midpoints of each indoor coil and outdoor coil circuit. Equipment not sensitive to refrigerant charge may, as an alternative, be provided with pressure measuring devices connected to access valves or tapped into the suction and discharge lines. The equipment shall then be operated at the desired conditions, with the indoor-side test apparatus connected and the outdoor side apparatus disconnected. Data shall be sampled at equal intervals that span five minutes or less for a period of one-half hour after equilibrium has been attained. The outdoor side test apparatus shall then be connected to the equipment and the pressure or temperatures indicated by the aforementioned instrumentation shall be noted. If, after equilibrium is again attained, the average of coil or pressure-equivalent saturation temperatures does not agree within ±0.3°C (±0.5°F) of the average coil or saturation temperatures observed during the preliminary test, the outdoor airflow rate shall be adjusted until the specified agreement is attained. The test shall be continued for a period of at least one-half hour at the proper conditions with the outdoor test apparatus connected. During this period, the indoor side test results shall agree within ±2.0% with the results obtained during the preliminary test period. This check of the effect of the test apparatus on performance shall be conducted for one cooling test and one heating test and may be conducted for any additional tests.

8.6.2 When the outdoor airflow rate is adjusted as described in 8.6.1, the adjusted airflow rate is employed in the capacity calculation. In such cases, however, the outdoor fan power input observed during the applicable preliminary test should be used for rating purposes.

8.7 Test Procedure for Cooling Capacity Tests

8.7.1 The test room reconditioning apparatus and the equipment under test shall be operated until steady-state performance that is consistent with the test tolerances specified in Table 2 is attained before cooling capacity test data are recorded.

8.7.2 Data used in evaluating cooling capacity shall then be recorded at equal intervals that span five minutes or less until readings over a period of one-half hour are within the tolerances prescribed in 9.2.

8.7.3 When the outdoor air enthalpy method is used, the requirements in 8.7.1 and 8.7.2 apply to both the preliminary test specified in 8.6.1 and test itself. When the compressor calibration method is employed, the above requirements apply to both the equipment test and the compressor calibration test.

8.8 Test Operating Procedure for Heating Capacity Tests

8.8.1 General

8.8.1.1 Heating capacity tests used to evaluate the heating performance of a heat pump when operating at conditions that are conducive to frost accumulation on the outdoor coil should be conducted using the “T” test procedure described in 8.8.3. Otherwise, the manufacturer shall have the option of first trying to use the “S” test procedure of 8.8.2. If the requirements of the “S” test procedure cannot be achieved, then the heating capacity test shall be conducted using the “T” test procedure described in 8.8.3.

8.8.1.2 Except as noted, overriding of automatic defrost controls shall be prohibited. The controls may only be overridden when manually initiating a defrost cycle is permitted.

8.8.1.3 For heat pumps that use a time-adaptive defrost control system, where defrost initiation depends on the length of previous defrost cycles, the defrost controls of the heat pump shall be defeated during the official data collection interval of all heating capacity tests. When the defrost controls are defeated, defrost cycles (if any) shall be manually induced in accordance with the manufacturer’s instructions.

8.8.1.4 Any defrost cycle, whether automatically or manually initiated, that occurs while conducting a heating capacity test shall always be terminated by the action of the heat pump’s defrost controls.

8.8.1.5 Defrost termination shall be defined as occurring when the controls of the heat pump actuate the first change in converting from defrost operation to normal heating operation. Whether automatically or manually initiated, defrost initiation shall be defined as occurring when the controls of the heat pump first alter its normal heating operation in order to eliminate possible accumulations of frost on the outdoor coil.

TABLE 2a Test Tolerances (SI Units)

	Test Operating Tolerance (Total Observed Range)				Test Condition Tolerance (Variation of Average from Specified Test Conditions)			
			Heat with Frost[a]				Heat with Frost[a]	
	Cooling	Non-Frosting	Heat Portion	Defrost Portion	Cooling	Non-Frosting	Heat Portion	Defrost Portion
Outdoor dry-bulb temperature (°C): Entering	1.0	1.0	1.7	5.6	0.3	0.3	0.5	–[c]
Outdoor dry-bulb temperature (°C): Leaving	1.0[b]	1.5[b]	–	–	–	–	–	
Outdoor wet-bulb temperature (°C): Entering	0.5	0.5	0.9	–	0.2[d]	0.2	0.3	–
Outdoor wet-bulb temperature (°C): Leaving	0.5[b]	0.5[b]	–	–	–	–	–	–
Indoor dry-bulb temperature (°C): Entering	1.0	1.0	1.7	2.2[e]	0.3	0.3	0.5	–[c]
Indoor dry-bulb temperature (°C): Leaving	1.0	1.5	–	–	–	–	–	
Indoor wet-bulb temperature (°C): Entering	0.5	0.5	–	–	0.2	–	–	–
Indoor wet-bulb temperature (°C): Leaving	0.5	0.5	–	–	–	–	–	–
Condenser cooling water temperature (°C)	0.3	0.3	–	–	0.1	0.1	–	–
Saturated refrigerant temperature corresponding to the measured indoor side pressure[f] (°C)	1.7	1.7	–	–	0.3	0.3	–	–
Liquid temperature if not otherwise specified (°C)	0.3	0.3	–	–	0.1	0.1	–	–
External resistance to airflow (Pa)	12.5	12.5	–	–	–	–	–	–
Electrical voltage (% of reading)	2.0	2.0	2.0	–	–	–	–	–
Liquid flow rate (% of reading)	2.0	2.0	–	–	–	–	–	–
Nozzle pressure drop (% of reading)	2.0	2.0	–	–	–	–	–	–

a The "heat portion" shall apply when the unit is in the heating mode except for the first ten minutes after terminating a defrost cycle. The "defrost portion" shall include the defrost cycle plus the first ten minutes after terminating the defrost cycle.
b Applies only when using the outdoor air enthalpy method.
c When these data are sampled within the defrost portion of the cycle, they shall be omitted when computing average temperatures for the tests.
d Applicable only when testing equipment that rejects condensate to the outdoor coil and when testing packaged systems where the indoor coil is located in the outdoor chamber.
e Not applicable if the indoor fan is stopped.
f Tolerance applies only for the compressor calibration and refrigerant enthalpy methods; the saturation temperature, in this case, shall be evaluated based on the pressure transducer located between the indoor coil and the compressor for the given operating mode, heating or cooling.

TABLE 2b Test Tolerances (I-P Units)

	Test Operating Tolerance (Total Observed Range)				Test Condition Tolerance (Variation of Average from Specified Test Conditions)			
			Heat with Frost[a]				Heat with Frost[a]	
	Cooling	Non-Frosting	Heat Portion	Defrost Portion	Cooling	Non-Frosting	Heat Portion	Defrost Portion
Outdoor dry-bulb temperature (°F): Entering	2.0	2.0	3.0	10.0	0.5	0.5	1.0	–[c]
Outdoor dry-bulb temperature (°F): Leaving	2.0[b]	3.0[b]	–	–	–	–	–	
Outdoor wet-bulb temperature (°F): Entering	1.0	1.0	1.5	–	0.3[d]	0.3	0.5	
Outdoor wet-bulb temperature (°F): Leaving	1.0[b]	1.0[b]	–	–	–	–	–	–
Indoor dry-bulb temperature (°F): Entering	2.0	2.0	3.0	4.0[e]	0.5	0.5	1.0	–[c]
Indoor dry-bulb temperature (°F): Leaving	2.0	3.0	–	–	–	–	–	
Indoor wet-bulb temperature (°F): Entering	1.0	1.0	–	–	0.3	–	–	–
Indoor wet-bulb temperature (°F): Leaving	1.0	1.0	–	–	–	–	–	–
Condenser cooling water temperature (°F)	0.5	0.5	–	–	0.2	0.2	–	–
Saturated refrigerant temperature corresponding to the measured indoor side pressure[f] (°F)	3.0	3.0	–	–	0.5	0.5	–	–
Liquid temperature if not otherwise specified (°F)	0.5	0.5	–	–	0.2	0.2	–	–
External resistance to airflow (inches of water)	0.05	0.05	–	–	–	–	–	–
Electrical voltage (% of reading)	2.0	2.0	2.0	–	–	–	–	–
Liquid flow rate (% of reading)	2.0	2.0	–	–	–	–	–	–
Nozzle pressure drop (% of reading)	2.0	2.0	–	–	–	–	–	–

a The "heat portion" shall apply when the unit is in the heating mode except for the first ten minutes after terminating a defrost cycle. The "defrost portion" shall include the defrost cycle plus the first ten minutes after terminating the defrost cycle.
b Applies only when using the outdoor air enthalpy method.
c When these data are sampled during the defrost portion of the cycle, they shall be omitted when computing average temperatures for the tests.
d Applicable only when testing equipment that rejects condensate to the outdoor coil and when testing packaged systems where the indoor coil is located in the outdoor chamber.
e Not applicable if the indoor fan is stopped.
f Tolerance applies only for the compressor calibration and refrigerant enthalpy methods; the saturation temperature, in this case, shall be evaluated based on the pressure transducer located between the indoor coil and the compressor for the given operating mode, heating or cooling.

8.8.2 "S" Test Procedure

8.8.2.1 For heat pumps having a rated cooling capacity that is less than 40 kW (135,000 Btu/h), a secondary measurement of heating capacity shall be made in accordance with 7.2.1.

8.8.2.2 The dry-bulb temperature of the air entering the indoor-side and the dry-bulb temperature and water vapor content of the air entering the outdoor-side shall be sampled at equal intervals that span one minute or less throughout the preconditioning and data collection periods. Over these same periods, all other applicable Table 2 non-frosting parameters used in evaluating equilibrium shall be sampled at equal intervals that span five minutes or less. All data collected over the respective periods, except for parameters sampled between a defrost initiation and ten minutes after the defrost termination, shall be used to evaluate compliance with the test tolerances specified in Table 2.

8.8.2.3 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 test data are recorded. At any time during the preconditioning period, the heat pump may undergo one or more defrost cycles if automatically initiated by its own controls. The preconditioning period may, in addition, end with a defrost cycle and this period ending defrost cycle may be either automatically or manually initiated. Ending the preconditioning period with a defrost cycle is especially recommended for heating capacity tests at low outdoor temperatures. If a defrost does occur, the heat pump shall operate in the heating mode for at least ten minutes after defrost termination prior to resuming or beginning the data collection described in 8.8.2.2 and 8.8.2.4, respectively.

8.8.2.4 Once the preconditioning described in 8.8.2.3 is completed, the data required for the specified or chosen test method(s) of 7.1 and 7.2 shall be collected. These data shall be sampled at equal intervals that span five minutes or less.

The difference between the dry-bulb temperature of the air leaving and entering the indoor coil, $\Delta t_{ai}(\tau)$, shall be evaluated at equal intervals that span five minutes or less. The temperature difference evaluated at the start of the data collection period, $\Delta t_{ai}(\tau = 0)$, shall be saved for purposes of evaluating 8.8.2.5.1 or 8.8.2.6.1 compliance.

8.8.2.5 Test Procedures If the Pre-Conditioning Period Ends with a Defrost Cycle

8.8.2.5.1 Data collection shall be suspended immediately if any of the following conditions occur prior to completing a 30-minute interval where the Table 2 non-frosting test tolerances are satisfied:

(a) if the heat pump undergoes a defrost;
(b) if the indoor-side dry-bulb temperature difference degrades such that the ratio $[\Delta t_{ai}(\tau = 0) - \Delta t_{ai}(\tau)] / \Delta t_{ai}(\tau = 0)$ exceeds 0.025; or
(c) if one or more of the applicable Table 2 non-frosting test tolerances are exceeded.

8.8.2.5.2 If the "S" test procedure is suspended because of condition "a" of 8.8.2.5.1, then the "T" test procedure described in 8.8.3 shall be used.

8.8.2.5.3 If the "S" test procedure is suspended because of condition "b" of 8.8.2.5.1, then the "T" test procedure described in 8.8.3 shall be used.

8.8.2.5.4 If the "S" test procedure is suspended because of condition "c" of 8.8.2.5.1, then another attempt at collecting data in accordance with 8.8.2 and the "S" test procedure shall be made as soon as steady performance is attained. An automatic or manually initiated defrost cycle may occur prior to making this subsequent attempt. If a defrost does occur, the heat pump shall operate in the heating mode for at least ten minutes after defrost termination prior to beginning the data collection described in 8.8.2.4. The preconditioning requirements in 8.8.2.3 are not applicable when making this subsequent attempt.

8.8.2.5.5 If the "S" test procedure is not suspended in accordance with 8.8.2.5.1, then the sampling specified in 8.8.2.4 shall be terminated after 30 minutes of data collection. The test, for which the Table 2 test tolerances for non-frosting apply, shall be designated as a completed steady-state heating capacity test.

8.8.2.6 Test Procedure If the Pre-Conditioning Period Does Not End with a Defrost Cycle

8.8.2.6.1 Data collection shall be suspended immediately if any of the following conditions occur prior to completing a 30-minute interval where the Table 2 non-frosting test tolerances are satisfied:

(a) if the heat pump undergoes a defrost;
(b) if the indoor-side dry-bulb temperature difference degrades such that the ratio $[\Delta t_{ai}(\tau = 0) - \Delta t_{ai}(\tau)] / \Delta t_{ai}(\tau = 0)$ exceeds 0.025; or
(c) if one or more of the applicable Table 2 non-frosting test tolerances are exceeded.

8.8.2.6.2 If the "S" test procedure is suspended because of condition "a" of 8.8.2.6.1, then another attempt at collecting data in accordance with 8.8.2.4 and 8.8.2.5 shall be made beginning ten minutes after the defrost cycle is terminated. The preconditioning requirements of 8.8.2.3 are not applicable when making this subsequent attempt.

8.8.2.6.3 If the "S" test procedure is suspended because of condition "b" of 8.8.2.6.1, then another attempt at collecting data in accordance with 8.8.2.4 and 8.8.2.5 shall be made. This subsequent attempt shall be delayed until ten minutes after the heat pump completes a defrost cycle. This defrost cycle should be manually initiated, if possible, in order to avoid the delay of having to otherwise wait for the heat pump to automatically initiate a defrost.

8.8.2.6.4 If the "S" test procedure is suspended because of condition "c" of 8.8.2.6.1, then another attempt at collecting data in accordance with 8.8.2 and the "S" test procedure shall be made as soon as steady performance is attained. An automatic or manually initiated defrost cycle may occur prior to making this subsequent attempt. If a defrost does occur, the heat pump shall operate in the heating mode for at least ten minutes after defrost termination prior to beginning the data collection described in 8.8.2.4. The preconditioning requirements in 8.8.2.3 are not applicable when making this subsequent attempt.

8.8.2.6.5 If the "S" test procedure is not suspended in accordance with 8.8.2.6.1, then the sampling specified in 8.8.2.4 shall be terminated after 30 minutes of data collection. The test, for which the Table 2 test tolerances for non-frosting apply, shall be designated as a completed steady-state heating capacity test.

8.8.3 "T" Test Procedure

8.8.3.1 Average heating capacity shall be determined using the indoor air enthalpy method. The outdoor air enthalpy method shall not be used and its associated outdoor-side measurement apparatus, if used in the previous test, shall be disconnected from the heat pump. In all cases, the normal outdoor-side airflow of the equipment shall not be disturbed. Use of a secondary test method is not required.

8.8.3.2 No changes in the airflow settings of the heat pumps shall be made. If the heat pump turns the indoor fan off during the defrost cycle, forced airflow through the indoor coil shall cease and the outlet duct shall be blocked while the fan is off.

8.8.3.3 The test tolerance given in Table 2, "heat with frost," shall be satisfied when conducting heating capacity tests using the "T" test procedure. As noted in Table 2, the test tolerances are specified for two sub-intervals. "Heat portion" consists of data collected during each heating interval, with the exception of the first ten minutes after defrost termination. "Defrost portion" consists of data collected during each defrost cycle plus the first ten minutes of the subsequent heating interval. The test tolerance parameters in Table 2 shall be sampled throughout the preconditioning and data collection periods. For the purpose of evaluating compliance with the specified test tolerances, the dry-bulb temperature of the air entering the indoor-side and the outdoor-side shall be sampled at least every minute during the heat portion and at least every 20 seconds during the defrost portion. The water vapor content of the air entering the outdoor-side shall be sampled at least every minute. All other Table 2 "heat with frost" parameters shall be sampled at equal intervals that span five minutes or less.

All data collected during each interval, heat portion and defrost portion, shall be used to evaluate compliance with the Table 2 "heat with frost" tolerances. Data from two or more heat portion intervals or two or more defrost portion intervals shall not be combined and then used in evaluating Table 2 "heat with frost" compliance. Compliance is based on evaluating data for each interval separately.

8.8.3.4 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. Elapsed time associated with a failed attempt using the "S" test procedure of 8.8.2 may be counted in meeting the minimum requirement for one hour of operation. Prior to obtaining equilibrium and completing one hour of operation, the heat pump may undergo a defrost(s) cycle if automatically initiated by its own controls.

8.8.3.5 Once the preconditioning described in 8.8.3.4 is completed, a defrost cycle shall occur before data are recorded. This defrost cycle should be manually initiated, if possible, in order to avoid the delay of having to otherwise wait for the heat pump to automatically initiate a defrost. Data collection shall begin at the termination of the defrost cycle and shall continue until one of the following criteria is met. If, at an elapsed time of three hours, the heat pump has completed at least one defrost cycle and a defrost cycle is not presently underway, then data collection shall be immediately terminated. If, at an elapsed time of three hours, the heat pump is conducting a defrost, the cycle shall be completed before terminating the collection of data. If three complete cycles are concluded prior to three hours, data collection shall be terminated at the end of the third cycle. A complete cycle consists of a heating period and a defrost period, from defrost termination to defrost termination. For a heat pump where the first defrost cycle is initiated after three hours but before six hours have elapsed, data collection shall cease when this first defrost cycle terminates. Data collection shall cease at six hours if the heat pump does not undergo a defrost cycle within six hours.

8.8.3.6 In order to constitute a valid test, the test tolerances in Table 2 "heat with frost" shall be satisfied during the applicable 8.8.3.5 test period. Because the test begins at defrost termination and may end at a defrost termination, the first defrost portion interval will only include data from the first ten-minute heating interval while the last defrost portion interval could potentially include data only from the last defrost cycle.

8.8.3.7 Except for the deviations noted for the dry-bulb temperatures, the data required for the indoor air enthalpy test method shall be sampled at equal intervals that span five minutes or less. The dry-bulb temperature of the air entering and leaving the indoor-side or, if a thermopile is used, the difference between these two dry-bulb temperatures shall be sampled at least every ten seconds during

1. defrost cycles and
2. the first ten minutes after a defrost termination (includes the first ten minutes of the data collection interval).

8.8.3.8 Average heating capacity shall be calculated in accordance with 7.3.5 using data from the total number of complete cycles that are achieved before data collection is terminated. In the event that the equipment does not undergo a defrost during the data collection interval, the entire six-hour data set shall be used for the calculations in 7.3.5.

9. DATA TO BE RECORDED

9.1 Table 3 shows the data to be recorded during a test. Items indicated by an "x" under the test method columns, or their equivalents, are required when that test method is employed.

9.2 Test Tolerances

9.2.1 All test observations shall be within the tolerances specified in Table 2, as appropriate to the test methods, type of equipment, and type of test (cooling, non-frosting, or heat with frost).

9.2.2 The maximum permissible variation of any observation during the capacity test is listed under "Test Operating Tolerance" in Table 2. This represents the greatest permissible difference between maximum and minimum instrument

TABLE 3 Data to be Recorded

Item	Indoor Air Enthalpy Method	Outdoor Air Enthalpy Method	Compressor Calibration Method	Refrigerant Enthalpy Method	Outdoor Liquid Coil Method	Cooling Condensate and Indirect Airflow Measurement
Date	X	X	X	X	X	X
Observer(s)	X	X	X	X	X	X
Barometric pressure, kPa [in. Hg]	X	X	X	X	X	X
Equipment nameplate data	X	X	X	X	X	X
Test interval times	X	X	X	X	X	X
Total power/energy input to equipment, W / Wh [W / Wh]		X			X	
Power input, indoor side, W [W]			X	X		
Applied voltage(s), V [V]	X	X	X	X	X	X
Frequency, [Hz]	X	X	X	X	X	X
External resistance to airflow, Pa [in. H_2O]	X	X	X	X	X	X
fan speed(s), setting	X	X	X	X	X	X
Dry-bulb temperature of air entering equipment, indoor side, °C [°F]	X	X	X	X	X	X
Wet-bulb temperature of air entering equipment, indoor side, °C [°F]	X	X	X	X	X	X
Dry-bulb temperature of air leaving equipment, indoor side, °C [°F]	X					X
Wet-bulb temperature of air leaving equipment, indoor side °C [°F]	X					X
Dry-bulb temperature of air entering equipment, outdoor side, °C [°F]	X	X	X	X		
Wet-bulb temperature of air entering equipment, outdoor side, °C [°F]	X	X	X	X		
Dry-bulb temperature of air leaving equipment, outdoor side, °C [°F]		X				
Wet-bulb temperature of air leaving equipment, outdoor side °C [°F]		X				
Throat diameter of nozzle(s), mm [in.]	X	X				
Velocity pressure at nozzle throat or static pressure difference across nozzle(s), Pa [in. H_2O]	X	X				
Temperature at nozzle throat, °C [°F]	X	X				
Pressure at nozzle throat, Pa [in. Hg]	X	X				
Condensing pressure or temperature, kPa or °C [psig or °F]			X	X		
Evaporator pressure or temperature, kPa or °C [psig or °F]			X	Note[a]		
Temp. of refrigerant vapor entering compressor, °C [°F]			X			
Temp. of refrigerant vapor leaving compressor, °C [°F]			X			
Temperature of high side refrigerant vapor leaving reversing valve, °C [°F]			X			
Refrigerant or surface temperature used for leakage coefficient determination, °C [°F]			X			
Refrigerant-oil flow rate, kg/s [lbm/h]				X		
Refrigerant volume in refrigerant-oil mixture, m^3/m^3 [ft^3/ft^3]				X		
Outdoor coil water flow rate, kg/s [lbm/h]					X	
Temperature of outdoor water entering equipment, °C [°F]					X	
Temperature of outdoor water leaving equipment, °C [°F]					X	
Rate of condensate collection, kg/s [lbm/h]						X
Refrigerant liquid temperature, indoor side, °C [°F]		Note[b]	X	X		
Refrigerant liquid temperature, outdoor side, °C [°F]		Note[b]	Note[b]	Note[b]		
Refrigerant vapor temperature, indoor side, °C [°F]		Note[b]	X	X		
Refrigerant vapor temperature, outdoor side, °C [°F]		Note[b]	Note[b]	Note[b]		
Refrigerant vapor pressure, indoor side, kPa [psig]			X	X		

a Required only during cooling capacity tests.
b Required only for line loss adjustment.

observations during the test. When expressed as a percentage, the maximum allowable variation is the specified percentage of the arithmetic average of the observations.

9.2.3 The maximum permissible variations of the average of the test observations from the standard or desired test conditions are shown in Table 2 under "Test Condition Tolerance."

9.2.4 Variations greater than those prescribed shall invalidate the test.

10. TEST RESULTS

10.1 Capacity Test Requirements

10.1.1 The results of a capacity test shall express quantitatively the effects produced upon air by the equipment tested. For given test conditions, the capacity test results shall include each of the following quantities that are applicable to cooling or heating and to the type of equipment tested:

(a) total cooling capacity, W [Btu/h]
(b) sensible cooling capacity, W [Btu/h]
(c) latent cooling capacity, W [Btu/h]
(d) heating capacity, W [Btu/h]
(e) indoor side airflow rate, m^3/s standard air [cfm]
(f) external resistance to indoor airflow, Pa [in. H_2O]
(g) total power input to equipment or power inputs to all equipment components, W [W]

Note: The capacities and power inputs may not include additional fan power required to move the air.

10.1.2 When two test methods are required, the total cooling or heating (except frosting) capacity shall be the indoor side capacity of the two simultaneously conducted methods of test and these two capacities shall agree within 6.0%. When the compressor calibration method is employed, "simultaneously conducted" shall be construed to mean that the needed refrigerant property measurements are made during the capacity test while either a prior or subsequent compressor calibration test is used in determining refrigerant flow rate or, for cases described in 7.4.1.1(b), in determining cooling capacity.

10.1.3 When two test methods for cooling are required, the sensible and latent cooling capacities shall be those determined using the indoor air enthalpy method.

10.1.4 Heating capacity under conditions of equipment cycling due to defrost cycles shall be determined using the indoor air enthalpy method. Heating capacity shall be based on airflow and the indoor air temperature rise (or drop when defrosting) averaged with respect to time for the entire test period. In the event the indoor air fan stops during defrosting, the capacity during this interval is considered to be zero; but this elapsed period of time must be included in the total test period for obtaining the average temperature rise for the indoor airstream. The net result for units in which no defrost occurs is the integrated capacity for the total test period. For units in which defrost occurs, the net result is the integrated capacity for the total number of complete cycles during the test period. A complete cycle consists of a heating period and a defrost period from defrost termination to defrost termination.

10.1.5 Test results shall be used to determine capacities without adjustment for permissible variations in test conditions.

10.1.6 Air enthalpies used in calculating space conditioning capacities shall be evaluated for the measured ambient conditions: dry-bulb temperature, water vapor content measurements, and barometric pressure.

11. SYMBOLS USED IN EQUATIONS

11.1 The significance of terms used in this standard is provided in Table 4.

TABLE 4 Symbols

A_n	=	nozzle area, m^2 [ft^2]
$c_{p_{a1}}$	=	specific heat of air entering the indoor side, $J/kg_{da}\cdot°C$ [$Btu/lbm_{da}\cdot°F$]
$c_{p_{a2}}$	=	specific heat of air leaving the indoor side, $J/kg_{da}\cdot°C$ [$Btu/lbm_{da}\cdot°F$]
$c_{p_{a3}}$	=	specific heat of air entering the outdoor side, $J/kg_{da}\cdot°C$ [$Btu/lbm_{da}\cdot°F$]
$c_{p_{a4}}$	=	specific heat of air leaving the outdoor side, $J/kg_{da}\cdot°C$ [$Btu/lbm_{da}\cdot°F$]
c_{p_l}	=	specific heat of the liquid (e.g., water), J/kg·°C [Btu/lbm·°F]
C	=	nozzle coefficient of discharge, dimensionless
D	=	nozzle throat diameter, mm [in.]
D_t	=	diameter of refrigerant tubing, mm [in. (OD)]
E_i	=	power input, indoor side, W [watts]
E_t	=	power input, total, W [watts]
h_{a1}	=	enthalpy, air entering indoor side, J/kg_{da} [Btu/lbm_{da}]
h_{a2}	=	enthalpy, air leaving indoor side, J/kg_{da} [Btu/lbm_{da}]
h_{a3}	=	enthalpy, air entering outdoor side, J/kg_{da} [Btu/lbm_{da}]
h_{a4}	=	enthalpy, air leaving outdoor side, J/kg_{da} [Btu/lbm_{da}]
h_{f1}	=	enthalpy of refrigerant liquid at a saturation temperature corresponding to the pressure of refrigerant vapor leaving the compressor, J/kg [Btu/lbm]
h_{f2}	=	enthalpy of refrigerant liquid leaving the condenser, J/kg [Btu/lbm]
h_{g1}	=	enthalpy of refrigerant vapor entering compressor under conditions specified, J/kg [Btu/lbm]
h_{g2}	=	enthalpy of refrigerant vapor entering condenser, J/kg [Btu/lbm]
h_{k1}	=	enthalpy, steam entering calorimeter evaporator, J/kg [Btu/lbm]
h_{k2}	=	enthalpy, fluid leaving calorimeter evaporator, J/kg [Btu/lbm]
h_{r1}	=	enthalpy, refrigerant entering indoor side, J/kg [Btu/lbm]
h_{r2}	=	enthalpy, refrigerant leaving indoor side, J/kg [Btu/lbm]
L	=	length of refrigerant line, m [ft]
P_a	=	pressure, barometric, kPa [in. Hg]
P_n	=	pressure at nozzle throat, Pa [in. H_2O]
P_v	=	velocity pressure at nozzle throat or static pressure difference across nozzle, Pa [in. H_2O]

TABLE 4 Symbols *(continued)*

q	=	compressor capacity as determined in accordance with ASHRAE Standard 23-1993, W [Btu/h]
q_e	=	heat input to calorimeter evaporator, W [Btu/h]
q_l	=	line loss, interconnecting tubing, W [Btu/h]
q_{lci}	=	latent cooling capacity, indoor side data, W [Btu/h]
$(q_{loss})_{IA}$	=	duct loss correction for the indoor air enthalpy method, W [Btu/h]
$(q_{loss})_{OA}$	=	duct loss correction for the outdoor air enthalpy method, W [Btu/h]
q_{sc}	=	sensible cooling capacity, W [Btu/h]
q_{sci}	=	sensible cooling capacity, indoor side data, W [Btu/h]
q_{sri}	=	sensible reheat capacity, indoor side data, W [Btu/h]
q_{tc}	=	total cooling capacity, compressor data, W [Btu/h]
q_{tci}	=	total cooling capacity, indoor side data, W [Btu/h]
q_{tco}	=	total cooling capacity, outdoor side data, W [Btu/h]
q_{th}	=	total heating capacity, compressor data, W [Btu/h]
q_{thi}	=	total heating capacity, indoor side data, W [Btu/h]
q_{tho}	=	total heating capacity, outdoor side data, W [Btu/h]
Q_i	=	airflow, indoor, calculated, m^3/s [cfm]
Q_{mi}	=	airflow, indoor, measured, m^3/s [cfm]
Q_{mo}	=	airflow, outdoor, measured, m^3/s [cfm]
Q_s	=	airflow, standard air, m^3/s [cfm]
Re	=	Reynolds number
t_a	=	temperature, ambient air, dry bulb, °C [°F]
t_{a1}	=	temperature, air entering indoor side, dry bulb, °C [°F]
$t_{a1}(\tau)$	=	dry-bulb temperature of air entering the indoor coil at elapsed time τ, °C [°F]; only recorded when indoor airflow is occurring
t_{a2}	=	temperature, air leaving indoor side, dry bulb, °C [°F]
$t_{a2}(\tau)$	=	dry-bulb temperature of air leaving the indoor coil at elapsed time τ, °C [°F]; only recorded when indoor airflow is occurring
t_{a3}	=	temperature, air entering outdoor side, dry bulb, °C [°F]
t_{a4}	=	temperature, air leaving outdoor side, dry bulb, °C [°F]

TABLE 4 Symbols *(continued)*

t_{a5}	=	temperature, air leaving reheat coil, dry bulb, °C [°F]
t_{ai}	=	temperature, air temperature within the indoor test room, dry bulb, °C [°F]
t_{ao}	=	temperature, air temperature within the outdoor test room, dry bulb, °C [°F]
t_c	=	temperature, surface, calorimeter condenser, °C [°F]
t_{r2}	=	temperature, refrigerant at outdoor unit, °C [°F]
t_s	=	temperature, saturated refrigerant, °C [°F]
t_{l3}	=	temperature, liquid entering outdoor side, °C [°F]
t_{l4}	=	temperature, liquid leaving outdoor side, °C [°F]
t_1	=	temperature, water entering calorimeter condenser, °C [°F]
t_2	=	temperature, water leaving calorimeter condenser, °C [°F]
Th	=	insulation thickness, interconnecting tubing, mm [inch]
UA_a	=	product of the overall condenser-to-air heat transfer coefficient and the outside surface area of the condenser, as determined from the separate evaporator-type calorimeter test method (see 7.4.4), W/°C [Btu/h °F]
$(UA_{duct})_{1o}$	=	product of the overall heat transfer coefficient and surface area for the indoor coil inlet duct that is located in the outdoor test room, W/°C [Btu/h °F]
$(UA_{duct})_{2i}$	=	product of the overall heat transfer coefficient and surface area for the indoor coil outlet duct that is located in the indoor test room, W/°C [Btu/h°F]
$(UA_{duct})_{2o}$	=	product of the overall heat transfer coefficient and surface area for the indoor coil outlet duct that is located in the outdoor test room, W/°C [Btu/h °F]
$(UA_{duct})_{4o}$	=	product of the overall heat transfer coefficient and surface area for the outdoor coil outlet duct that is located in the outdoor test room, W/°C [Btu/h °F]
v_{ai}	=	specific volume of air leaving indoor side, m^3/kg_{da} [ft^3/lbm_{da}]
v_{i1}	=	specific volume of air, entering indoor side, m^3/kg_{da} [ft^3/lbm_{da}]
v_n	=	specific volume of the dry air portion of the mixture evaluated at the dry-bulb temperature and barometric pressure at the nozzle exit, and the vapor content evaluated at the leaving conditions, m^3/kg_{da} [ft^3/lbm_{da}]

TABLE 4 Symbols *(continued)*

v_{nsp}	=	specific volume of the dry air portion of the mixture evaluated at the dry-bulb temperature at the nozzle exit and the vapor content evaluated at the leaving conditions, but at standard barometric pressure, m^3/kg_{da} [ft^3/lbm_{da}]
v'_n	=	specific volume of air at the nozzle, m^3/kg [ft^3/lbm] of air-water vapor mixture
V_a	=	velocity of air, at nozzle, m/s [fpm]
V_{ro}	=	volume flow rate, refrigerant-oil mixture, m^3/s [ft^3/h]
w_{ai}	=	mass flow rate, indoor dry air, kg_{da}/s [lbm_{da}/h]
w_c	=	mass flow rate, indoor coil condensate, kg/s [lbm/h]
w_k	=	mass flow rate, fluid condensate (steam), kg/s [lbm/h]
w_r	=	mass flow rate, refrigerant, kg/s [lbm/h]
w_l	=	mass flow rate, liquid, kg/s [lbm/h]
w_{ro}	=	mass flow rate, refrigerant oil mixture, kg/s [lbm/h]
W_1	=	humidity ratio, air entering indoor side, kg water vapor per kg of dry air [lbm_{wv}/lbm_{da}]
W_2	=	humidity ratio, air leaving indoor side, kg water vapor per kg of dry air [lbm_{wv}/lbm_{da}]
W_3	=	humidity ratio, air entering outdoor side, kg water vapor per kg of dry air [lbm_{wv}/lbm_{da}]
W_4	=	humidity ratio, air leaving outdoor side, kg water vapor per kg of dry air [lbm_{wv}/lbm_{da}]
W_n	=	humidity ratio at the nozzle, kg water vapor per kg of dry air [lbm_{wv}/lbm_{da}]
x	=	mass ratio, refrigerant to refrigerant-oil mixture
ρ	=	density of refrigerant, kg/m^3 [lbm/ft^3]
Δt	=	temperature difference, °C [°F]
Γ	=	the integrated (with respect to elapsed time) air temperature difference across the indoor coil, °C·h [°F·h]
τ_1	=	the elapsed time when the defrost termination occurs that begins the official test period, h
τ_2	=	the elapsed time when the last defrost termination occurs, h; if no defrost cycles occur during the data collection interval, τ_2 equals the elapsed time for the total data collection interval
μ	=	dynamic air viscosity, kg/m·s [lbm/ft·s]

12. REFERENCE PROPERTIES AND DATA

12.1 Thermodynamic Properties of Air

12.1.1 The thermodynamic properties of air-water vapor mixture shall be obtained from the equations in the psychrometric chapter in *2001 ASHRAE Handbook—Fundamentals*.[10]

12.2 Thermodynamic Properties of (Sink and Source) Liquids

12.2.1 The thermodynamic properties of liquids shall be obtained from *2001 ASHRAE Handbook—Fundamentals*.[10]

12.3 Thermodynamic Properties of Volatile Refrigerants

12.3.1 The thermodynamic properties of volatile refrigerants shall be obtained from *2001 ASHRAE Handbook—Fundamentals*[10] or from an established refrigerant property database.

13. REFERENCES

[1] *ANSI/ASHRAE Standard 41.1-1986 (RA 2006), Standard Method for Temperature Measurement*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

[2] *ANSI/ASHRAE Standard 41.6-1994 (RA 2006), Standard Method for Measurement of Moist Air Properties*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

[3] *ASHRAE Standard 41.3-1989, Standard Method for Pressure Measurement*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

[4] *ARI Standard 700-2006, Specifications for fluorocarbons and other refrigerants.* Air-Conditioning and Refrigeration Institute.

[5] *ANSI/ASHRAE Standard 51-1999, Laboratory Methods of Testing Fans for Aerodynamic Performance Rating* (ANSI/AMCA Standard 210-99). American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

[6] Bohanon, H.R., "Fan Test Chamber-Nozzle Coefficients," *ASHRAE Transactions*, Vol. 81, Part 1 (formerly ASHRAE paper No. 2334, 1975), American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA 30329 USA.

[7] *ASHRAE Standard 23-2005, Methods of Testing for Rating Positive Displacement Refrigerant Compressors and Condensing Units*, American Society of Heating,Refrigerating, and Air-Conditioning Engineers.

[8] *ANSI/ASHRAE Standard 41.9-2000 (RA 2006), Calorimeter Test Methods for Mass Flow Measurement of Volatile Refrigerants*, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., Atlanta, GA 30329 USA.

[9] *ANSI/ASHRAE Standard 41.4-1996 (RA 2006), Standard Method for Measurement of Proportion of Lubricant in Liquid Refrigerant,* American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

[10] *2005 ASHRAE Handbook--Fundamentals,* American Society of Heating, Refrigerating, and Air-Conditioning Engineers.

(This appendix is not part of this standard. It is merely informative and does not contain requirements necessary for conformance to the standard. It has not been processed according to the ANSI requirements for a standard and may contain material that has not been subject to public review or a consensus process. Unresolved objectors on informative material are not offered the right to appeal at ASHRAE or ANSI.)

INFORMATIVE APPENDIX A—CLASSIFICATIONS OF UNITARY AIR-CONDITIONERS AND HEAT PUMPS

Tables A-1 and A-2 provide the Air-Conditioning and Refrigeration Institute (ARI) classifications for unitary air conditioners and heat pumps for the convenience of users of this standard. These classifications can be found in *ARI Standard 210/240-2003, Unitary Air-Conditioning and Air-Source Heat Pump Equipment*, published by Air-Conditioning and Refrigeration Institute.

TABLE A-1 Classification of Unitary Air-Conditioners

Types of Unitary Air-Conditioners			
Designation	**ARI Type**	**Heat Rejection**	**Arrangement**
Single package	SP-A SP-E SP-W	Air Evap Cond Water	FAN / COMP EVAP / COND
Refrigeration chassis	RCH-A RCH-E RCH-W	Air Evap Cond Water	COMP EVAP / COND
Year-round single package	SPY-A SPY-E SPY-W	Air Evap Cond Water	FAN HEAT / COMP EVAP / COND
Remote condenser	RC-A RC-E RC-W	Air Evap Cond Water	FAN EVAP / COND COMP
Year-round remote condenser	RCY-A RCY-E RCY-W	Air Evap Cond Water	FAN EVAP / COND HEAT COMP
Condensing unit, coil(s) alone	RCU-A-C RCU-E-C RCU-W-C	Air Evap Cond Water	EVAP / COND COMP
Condensing unit, coil(s) and blower(s)	RCU-A-B RCU-E-CB RCU-W-CB	Air Evap Cond Water	FAN / COND EVAP / COMP
Year-round condensing unit and blower(s)	RCUY-A-CB RCUY-E-CB RCUY-W-CB	Air Evap Cond Water	FAN EVAP / COND HEAT / COMP

TABLE A-2 Classification of Air-Source Unitary Heat Pumps

Types of Air-Source Unitary Heat Pumps			
	ARI Type		
Designation	**Heating and Cooling**	**Heating Only**	**Arrangement**
Single package	HSP-A	HOSP-A	FAN | COMP INDOOR COIL | OUTDOOR COIL
Remote outdoor coil	HRC-A-CB	HORC-A-CB	FAN INDOOR COIL COMP OUTDOOR COIL
Remote outdoor coil with no indoor fan	HRC-A-C	HORC-A-C	INDOOR COIL COMP OUTDOOR COIL
Split system	HRCU-A-CB	HORCU-A-CB	FAN INDOOR COIL COMP OUTDOOR COIL
Split system with no indoor fan	HRCU-A-C	HORCU-A-C	INDOOR COIL COMP OUTDOOR COIL

POLICY STATEMENT DEFINING ASHRAE'S CONCERN FOR THE ENVIRONMENTAL IMPACT OF ITS ACTIVITIES

ASHRAE is concerned with the impact of its members' activities on both the indoor and outdoor environment. ASHRAE's members will strive to minimize any possible deleterious effect on the indoor and outdoor environment of the systems and components in their responsibility while maximizing the beneficial effects these systems provide, consistent with accepted standards and the practical state of the art.

ASHRAE's short-range goal is to ensure that the systems and components within its scope do not impact the indoor and outdoor environment to a greater extent than specified by the standards and guidelines as established by itself and other responsible bodies.

As an ongoing goal, ASHRAE will, through its Standards Committee and extensive technical committee structure, continue to generate up-to-date standards and guidelines where appropriate and adopt, recommend, and promote those new and revised standards developed by other responsible organizations.

Through its *Handbook*, appropriate chapters will contain up-to-date standards and design considerations as the material is systematically revised.

ASHRAE will take the lead with respect to dissemination of environmental information of its primary interest and will seek out and disseminate information from other responsible organizations that is pertinent, as guides to updating standards and guidelines.

The effects of the design and selection of equipment and systems will be considered within the scope of the system's intended use and expected misuse. The disposal of hazardous materials, if any, will also be considered.

ASHRAE's primary concern for environmental impact will be at the site where equipment within ASHRAE's scope operates. However, energy source selection and the possible environmental impact due to the energy source and energy transportation will be considered where possible. Recommendations concerning energy source selection should be made by its members.

About ASHRAE

The American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), founded in 1894, is an international organization of some 50,000 members. ASHRAE fulfills its mission of advancing heating, ventilation, air conditioning, and refrigeration to serve humanity and promote a sustainable world through research, standards writing, publishing, and continuing education.

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