BSR/ASHRAE Standard 190-2013R

Public Review Draft

Method of Testing for Rating Indoor Pool Dehumidifiers

First Public Review (July 2019)
(Complete Draft for Full Review)

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FOREWORD

This standard was prepared under the auspices of 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.

1. PURPOSE

The purpose of this standard is to prescribe test methods for determining the moisture removal capacity and efficiency, the pool heating capacity, and sensible and total cooling capacity for indoor pool dehumidifiers.

2. SCOPE

2.1 This standard applies to indoor pool dehumidifiers using electrically driven, mechanical vapor-compression refrigeration systems consisting of one or more factory-made assemblies that dehumidify and circulate air and may include pool water heating, air reheating, cooling, filtering, and heat recovery.

2.2 Systems other than the above (e.g., cooling only equipment) are excluded.

3. INSTRUMENTS

3.1 Temperature-Measuring Instruments

3.1.1 All temperature measurements shall be made in accordance with ANSI/ASHRAE Standard 41.1 *Standard Method for Temperature Measurement*.

3.2 Pressure-Measuring Instruments

3.2.1 Pressure measurements shall be made in accordance with ASHRAE Standard 41.3 *Standard Method for Pressure Measurement*.

3.3 Air Velocity and Airflow Measurements

3.3.1 The static pressure difference across nozzles and velocity pressures at nozzle throats shall be measured according to ASHRAE Standard 41.2 *Standard Method for Air Velocity and Airflow Measurement.*

3.4 Power Measurements

3.4.1 Power measurements shall be made in accordance with ASHRAE Standard 41.11 *Standard Methods for Power Measurements***.**

3.5 Liquid Flow Measurement

3.5.1 Water flow rates shall be measured with a liquid flowmeter or quantity meter having an accuracy of ±1.0% of the indicated value in accordance with ASHRAE Standard 41.8 *Standard Methods of Measurement for Liquid Flow Measurements*.

3.5.2 Condensate collection rates shall be determined using a liquid quantity meter having an accuracy of ±1.0% of the indicated value in accordance with ASHRAE Standard 41.8 *Standard Methods of Measurement for Liquid Flow Measurements*.

3.6 Time and Mass Measurements

3.6.1 Time interval measurements shall be made with an instrument having an accuracy of ±0.2% of the indicated value.

3.6.2 Mass measurements shall be made with an instrument having an accuracy of ±1.0% of the indicated value.

3.7 Humidity Measurements

3.7.1 Humidity measurements shall be made in accordance with ASHRAE Standard 41.6 *Standard for Humidity Measurement*.

4. METHODS OF TESTING AND CALCULATION

4.1 Standard Test Method

4.1.1 The following test method for measuring space-conditioning capacity, for all component arrangements shown in Table 1, is covered in this standard:

a. Indoor Air Enthalpy Method.

4.1.2 For the validation of the air enthalpy measurements, it is required to use the cooling condensate mass method. Section 5.2 describes a method for measuring cooling condensate and determining moisture removal capacity.

TABLE 1 Applicable Test Methods for Dehumidifying, Cooling, Reheating, and/or Water Heating

Component Arrangement	Method of Heat Rejection	Indoor Air-Enthalpy Method
Single Package Indoor	Air Reheat	X
	Pool Water	
	Air Reheat & Pool Water	
Single Package Indoor Water-Cooled	Air Reheat	X
	Pool Water	
	Air Reheat & Pool Water	
	A/C Condenser & Pool Water	
	A/C Condenser	
Single Package Indoor Air-Cooled	Air Reheat	X
	Pool Water	
	Air Reheat & Pool Water	
	A/C Condenser & Pool Water	
	A/C Condenser	
Split System Indoor Air-Cooled	Air Reheat	X
	Pool Water	
	Air Reheat & Pool Water	
	A/C Condenser & Pool Water	
	A/C Condenser	

4.2 Cooling Condensate Measurement

4.2.1 The latent cooling capacity shall be determined from the measurements of the condensate flow rate. The drain connection should be trapped to stabilize condensate flow.

4.2.2 Calculations

4.2.2.1 Latent cooling capacity is calculated as follows:

$$q_{lci} = 1061 \cdot w_c \; [= 2.47 \cdot 10^6 \cdot w_c] \qquad (1)$$

4.2.2.2 The sensible cooling capacity is then calculated as follows:

$$q_{sci} = q_{tci} - q_{lci} \qquad (2)$$

4.3 Indoor Air Enthalpy Methods

4.3.1 Space-conditioning capacity is determined measuring airflow rate, 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 *Standard Method for Measurement of Moist Air Properties*.

4.3.2 This method shall be used for equipment having total cooling capacities of less than 135,000 Btu/h (39.6 kW) and may be used for equipment with greater capacities.

4.3.3 Cooling Calculations

4.3.3.1 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:[1]

$$q_{tci} = \frac{60Q_{mi}(h_{a1}-h_{a2})}{v_n} = \frac{60Q_{mi}(h_{a1}-h_{a2})}{v_n'(1+W_n)} \quad (3)$$

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

$$q_{sci} = \frac{60Q_{mi}(c_{pa1}t_{a1}-c_{pa2}t_{a2})}{v_n} = \frac{60Q_{mi}(c_{pa1}t_{a1}-c_{pa2}t_{a2})}{v_n'(1+W_n)} \quad (4)$$

$$\left[= \frac{Q_{mi}(c_{pa1}t_{a1}-c_{pa2}t_{a2})}{v_n} = \frac{Q_{mi}(c_{pa1}t_{a1}-c_{pa2}t_{a2})}{v_n'(1+W_n)} \right]$$

where

$$c_{pa1} = 0.24 + 0.444W_1 \quad \left[= 1005 + 1805W_1 \right] \quad (5)$$

$$c_{pa2} = 0.24 + 0.444W_2 \quad \left[= 1005 + 1805W_2 \right] \quad (6)$$

and

$$q_{lci} = (1061)(60)\frac{Q_{mi}(W_1-W_2)}{v_n} = (1061)(60)\frac{Q_{mi}(W_1-W_2)}{v_n'(1+W_n)}$$

$$\left[= 2.47\times10^6 \frac{Q_{mi}(W_1-W_2)}{v_n'(1+W_n)} \right] \quad (7)$$

[1] The latent indoor cooling capacity is a function of the latent heat of vaporization (hfg) of water. In equations for qlci, the hfg, 1061 Btu/lb (2.47·106 J/kg), corresponding to 57ºF (14ºC) is used. Also, the energy associated with the leaving condensate is not included because its impact on net capacity is negligible.

4.3.3.2 When the indoor 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 the equipment indoor section is located in the indoor test room, then

$$(q_{loss})_{IA} = (UA_{duct})_{2i}\,(t_{a1} - t_{a2}) \quad (8)$$

If the equipment indoor section is located in an outdoor test room, then

$$(q_{loss})_{IA} = (UA_{duct})_{Io}\,(t_{ao} - t_{a1}) + (UA_{duct})_{2o}\,(t_{ao} - t_{a2}) + (UA_{duct})_{2i}\,(t_{a1} - t_{a2}) \quad (9)$$

4.3.4 Calculations Net Air Reheating

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

$$q_{thi} = (60)\frac{Q_{mi}c_{pa2}\left(t_{a2}-t_{a1}\right)}{v_n} = (60)\frac{Q_{mi}c_{pa2}\left(t_{a2}-t_{a1}\right)}{v'_n\left(1+W_n\right)} \left[= \frac{Q_{mi}c_{pa2}\left(t_{a2}-t_{a1}\right)}{v_n} \quad = \frac{Q_{mi}c_{pa2}\left(t_{a2}-t_{a1}\right)}{v'_n\left(1+W_n\right)} \right] \quad (10)$$

where c_{pa2} is calculated as specified in Section 5.3.3.1 and

$$W_n = W_1 = W_2 \quad (11)$$

4.3.4.2 When the indoor 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 Section 5.3.3.1 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.

4.3.5 Moisture-Removal-Capacity Calculations

4.3.5.1 The total moisture removal capacity based on test data collected according to the indoor air enthalpy method shall be calculated using the following equation:

$$w_{cc} = (60)\frac{Q_{mi}(W_1 - W_2)}{v_n(1+W_n)}$$

$$\left[= \frac{Q_{mi}(W_1 - W_2)}{v_n(1 + W_n)} \right] \quad (12)$$

4.4 Airflow Rate Measurement

4.4.1 Measurement Methods—According to Rated Cooling Capacity

4.4.1.1 For equipment having a rated cooling capacity less than 135,000 Btu/h (40 kW), the indoor airflow rate shall be measured using the nozzle airflow-measuring apparatus described in ASHRAE Standard 41.2 *Standard Methods for Air Velocity and Airflow Measurement*. 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.

4.4.1.2 For equipment having a rated capacity of 135,000 Btu/h (40 kW) or higher, the indoor airflow rate may be measured as described in Section 5.4.1.1. For cases where capacity exceeds the capacity of the apparatus described in Section 5.4.1.1., airflow rate shall be determined indirectly. Indirect determination shall be achieved by using the calculated capacity.

4.4.2 Calculations—Airflow-Measuring Apparatus

4.4.2.1 Calculations shall be made using the following calculation when referring to airflow measurements described in ASHRAE Standard 41.2 *Standard Methods for Air Velocity and Airflow Measurement*.

4.4.3 Calculations—Indirect Determination of Airflow Rate

4.4.3.1 The airflow rate shall be evaluated using the following equations:

For cooling:

$$Q_i = \frac{q_{tci} \; v_1}{60\,(h_{a1} - h_{a2})}$$

$$\left[= \frac{q_{tci} \; v_1}{(h_{a1} - h_{a2})} \right] \quad (13)$$

For heating:

$$Q_i = \frac{q_{thi} v_1}{60(h_{a1} - h_{a2})} \quad \left[= \frac{q_{thi} v_1}{(h_{a2} - h_{a1})} \right] \quad (14)$$

4.4.3.2 The airflow rate expressed in terms of standard air (*Qs*) shall be evaluated based on the indoor coil entering air-property measurements.

5. TEST PROCEDURES

5.1 Test-Room Requirements

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

5.1.2 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 500 fpm (2.5 m/s).

5.1.3 An outdoor-condition test room or space is required for tests of air-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 6.0 ft (1.8 m), and the distance from any other room surface to any other equipment surface is not less than 3.0 ft (0.9 m), 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.

5.2 Equipment Installation

5.2.1 The equipment to be tested shall be installed in the test room(s) in accordance with the manufacturer's installation instructions and following one of the arrangements in Figures 1-4. 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. In all cases, the manufacturer's recommendations with respect to distances from adjacent walls, amount of extensions through walls, etc., shall be followed.

5.2.2 No alterations to the equipment shall be made except for the attachment of required test apparatus and instruments in the prescribed manner. The entire test apparatus shall not have a leakage rate that exceeds 20 cfm (0.01 m^3/s) when a negative pressure of 1.0 in. H_2O (0.25 kPa) is maintained at the apparatus exit air location.

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

5.2.4 Interconnecting tubing shall be as furnished or prescribed by the manufacturer. In the absence of other instructions, 25 ft (7.6 m) of tubing shall be used, at least 10 ft (3 m) of which is located in the outdoor test room. Use Figure 6 as a guide.

5.2.5 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.

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

5.3 Airflow Measurements

5.3.1 The airflow-measuring device shall provide measurements in accordance with the provisions of Section 5.4.

5.4 External Resistance Measurement

5.4.1 External resistances shall be measured in accordance with the provisions of Section 3.2. Connections to equipment outlets (Figure 5) shall comply with the provisions of Section 3.2.

5.5 Temperature Measurement

5.5.1 Temperature measurements shall be made in accordance with ANSI/ASHRAE Standard 41.1 *Standard Method for Temperature Measurement*.

5.5.2 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 *Standard Method for Temperature Measurement*. 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.

5.5.3 Indoor inlet dry-bulb temperature and water vapor content measurement shall be taken at not less than three positions equally spaced over the equipment inlet area, or equivalent sampling means shall be provided. For units without an inlet duct connection or enclosure, the dry-bulb temperature and water vapor content measuring instruments or sampling devices shall be located approximately 6.0 in. (150 mm) from the equipment inlet opening or openings.

5.5.4 Wet-bulb measurements shall be corrected in accordance with ANSI/ASHRAE Standard 41.1 *Standard Method for Temperature Measurement*.

5.6 Test Procedure: Cooling, Dehumidifying, and Pool-Water-Heating Capacity

5.6.1 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 3 is attained before cooling-capacity test data are recorded.

5.6.2 Data used in evaluating cooling capacity shall then be recorded at equal intervals that span 5 min or less until readings over a period of 30 min. are within the tolerances prescribed in Section 7.2.

6. DATA TO BE RECORDED

6.1 Table 2 shows the data to be recorded during a test. Items indicated by an "X" under the test method columns, or their equivalent, are required when that test method is used.

TABLE 2 Data to be Recorded

Item	Units		Condensate Measurement Method	Air-Enthalpy Method
	I-P	SI		
Date			X	X
Observer			X	X
Barometric pressure	in Hg	kPa	X	X
Equipment nameplate data			X	X
Times	h	h	X	X
Power input to equipment	W	W	X	X
Applied voltage	V	V	X	X
Amperage	A	A	X	X
Frequency	Hz	Hz	X	X
External resistance to airflow	in H_2O	kPa	X	X
Fan speed, if adjustable	rpm	rev/s	X	X
Dry-bulb temperature of air entering equipment	ºF	ºC	X	X
Wet-bulb temperature of air entering equipment	ºF	ºC	X	X
Dry-bulb temperature of air leaving equipment	ºF	ºC	X	X
Wet-bulb temperature of air leaving equipment	ºF	ºC	X	X
Throat diameter of nozzle	in	mm		X
Velocity pressure at nozzle throat or static pressure difference across nozzle	in H_2O	kPa		X
Temperature at nozzle throat	ºF	ºC		X
Absolute pressure at nozzle throat	in	kPa		X
Temperature of pool water entering equipment	ºF	ºC	X	X
Temperature of pool water leaving equipment	ºF	ºC	X	X

Saturated refrigerant suction temperatures	ºF	ºC	X	X
Liquid refrigerant temperatures	ºF	ºC	X	X
Refrigerant suction pressure+	psig	kPa	X	X
Liquid refrigerant pressure+	psig	kPa	X	X
Compressor discharge refrigerant pressure+	psig	kPa	X	X
Compressor discharge refrigerant temperatures	ºF	ºC	X	X
Refrigerant Type			X	X
Pool water flow rate through equipment	gpm	L/s	X	X
Temperature of water entering water cooled condenser	ºF	ºC	X	X
Pressure drop across water cooled condenser	psi	kPa	X	X
Rate of condensate collection	lb/h	kg/h	X	
Calculated airflow rate through equipment	cfm	m^3/s		X

+ If instrument ports available.

TABLE 3 Test Tolerances

Readings	Test Operating Tolerances (Total Observed Range)		Test Condition Tolerance	
	Cooling, Dehumidifying, and Pool Water Heating		Cooling, Dehumidifying, and Pool Water Heating	
All Air Temperatures	°F	[°C]	°F	[°C]
Outdoor dry-bulb:				
entering	2.0	1.1	±0.5	±0.3
leaving	2.0	1.1	-	-
Indoor dry-bulb:				
entering	2.0	1.1	±0.5	±0.3
leaving	2.0	1.1	-	-
Indoor wet-bulb:				
entering	1.0	0.6	±0.3	±0.2
leaving	1.0	0.6	±0.3	±0.2
Water temperatures	1.0	0.6	±0.5	±0.3
External resistance to airflow	in H_2O 0.1	kPa 0.03	in H_2O ±0.02	kPa ±0.01
Electrical voltage, %	2.0		-	
Fluid flow rate, %	2.0		-	
Nozzle pressure drops, % of reading	2.0		-	
Condensate measurement %	10.0		-	

6.2 Test Tolerances

6.2.1 All test observations shall be within the tolerances specified in Table 3, as appropriate to the test methods, type of equipment, and type of test.

6.2.2 The maximum permissible variation of any observation during the capacity test is listed under "Test Operating Tolerances" in Table 3. This represents the greatest permissible difference between maximum and minimum instrument observations during the test. When expressed as a percentage, the maximum allowable variation is the specified percentage of the arithmetical average of the observations.

6.2.3 The maximum permissible variations of the average of the test observations from the standard or desired test conditions are shown in Table 3 under "Test Condition Tolerance."

6.2.4 Variations greater than those prescribed shall invalidate the test.

7. TEST RESULTS

7.1 Capacity Test Requirements

7.1.1 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, dehumidifying, or pool water heating and to the type of equipment tested:

- Moisture removal rate (condensate), lb/h (kg/h)
- Total power input to equipment or power inputs to all equipment components, W (W)
- Net cooling capacity, Btu/h (W)
- Net reheat capacity, Btu/h (W)
- Pool water heating capacity, Btu/h (W)
- Indoor-side airflow rate, cfm (m^3/s)
- External resistance to indoor airflow, in. H_2O (kPa).

7.1.2 The test results shall be considered valid when the moisture removal capacity of the two simultaneously conducted methods of test agrees within ±10%. The test results obtained from the air enthalpy method shall be the basis for rating the equipment.

7.1.3 Test results from the condensate measurement shall be used to determine capacities without adjustment for permissible variations in test conditions except as specified for deviations from standard barometric pressure.

7.1.4 Air enthalpies shall be corrected for deviations from saturation temperature and standard barometric pressure.

7.1.5 When the compressor calibration method is used, "simultaneously conducted" shall be construed to mean obtaining the operating conditions for the compressor calibration test.

7.2 Calculations of Results

7.2.1 Moisture removal capacity shall be determined by the pounds of moisture collected by the condensate measurement method (primary test method).

7.2.2 Moisture removal efficiency shall be calculated by taking the moisture removal capacity divided by the total input power.

8. SYMBOLS USED IN EQUATIONS

8.1 Symbols Used in this Standard are as Follows:

Cpa1= specific heat of air entering the indoor side, Btu/lb*da* °F (J/[Kg*da* °C])
Cpa2= specific heat of air leaving the indoor side, Btu/lb*da* °F (J/(Kg*da* °C])
cw = heat capacity of water, Btu/1b·°F (J/kg·°C)
da = dry air
Ei = power input, indoor side, W (W)
ha1 = enthalpy, air entering indoor side, Btu/lb*da* (J/kg*da*)
ha2 = enthalpy, air leaving indoor side, Btu/lb*da* (J/kg*da*)
hr1 = enthalpy, refrigerant entering indoor side, Btu/lb (J/kg)
hr2 = enthalpy, refrigerant leaving indoor side, Btu/lb (J/kg)
Qi = airflow, indoor, calculated, cfm (m3/s)
Qmi = airflow, indoor, measure, cfm (m3/s)
Qs = airflow, standard air, cfm (m3/s)
qlci = latent cooling capacity, indoor-side data, Btu/h (W)
qcw = condenser water-side capacity, Btu/h (W)
qpw = pool water heating capacity, Btu/h (W)
qsci = sensible cooling capacity, indoor-side data, Btu/h (W)
qtci = total cooling capacity, indoor-side data, Btu/h (W)
qthi = total heating capacity, indoor-side data, Btu/h (W)
(*q*loss)*IA* = duct loss correction for the indoor air enthalpy method, Btu/h (W)
ta = temperature, ambient air, dry-bulb, °F (°C)
tao = temperature, air temperature within the outdoor test room, dry-bulb, °F (°C)
*ta*1 = temperature, air entering indoor side, dry-bulb, °F (°C)
*ta*2 = temperature, air leaving indoor side, dry-bulb, °F (°C)
tw = temperature, water entering outdoor side, °F (°C)
*tw*3 = temperature, water entering outdoor side, °F (°C)
*tw*4 = temperature, water leaving outdoor side, °F (°C)
*tw*5 = temperature, pool water entering equipment, °F (°C)
*tw*6 = temperature, pool water leaving equipment, °F (°C)
(*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, Btu/h·°F (W/°C)
(*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, Btu/h·°F (W/°C)
(*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, Btu/h·°F (W/°C)

$v1$ = specific volume of dry-air portion of the mixture entering the indoor coil by measuring the dry-bulb temperature and water vapor content of the air, ft3/lb*da* (m3/kg*da*)
v_n = specific volume of air at dry- and wet-bulb temperature conditions existing at nozzle but at standard barometric pressure, ft^3/lb of dry air
v'_n = specific volume of air at nozzle, ft^3/lb of air/water mixture
$W1$ = humidity ratio, air entering indoor side, lb of water vapor per lb of dry air, lb*wv*/lb*da* (kg*wv*/kg*da*)
$W2$ = humidity ratio, air leaving indoor side, lb of water vapor per lb of dry air, lb*wv*/lb*da* (kg*wv*/kg*da*)
Wn = humidity ratio at the nozzle, lb*wv*/lb*da* (kg*wv*/kg*da*)
wc = mass flow rate, indoor coil condensate, lb/h (kg/s)
wcc = calculated moisture removal capacity, lb*wv*/h (kg*wv*/s)
wcw = calculated condenser water-side capacity, lb*wv*/h (kg*wv*/s)
wpw = flow rate, pool water, lb (kg/s)
wr = mass flow rate, refrigerant, lb/h (kg/s)
μ= dynamic air viscosity, lb/ft·s (kg/m·s)

9. REFERENCE PROPERTIES AND DATA

9.1 Thermodynamic Properties of Air

9.1.1 The thermodynamic properties of air/water-vapor mixture shall be obtained from the equations in *ASHRAE Handbook—Fundamentals*.

9.2 Thermodynamic Properties of Water and Steam

9.2.1 The thermodynamic properties of water and steam shall be obtained from *ASHRAE Handbook— Fundamentals*.

9.3 Thermodynamic Properties of Volatile Refrigerants

9.3.1 The thermodynamic properties of volatile refrigerants may be obtained from *ASHRAE Handbook—Fundamentals*, or from an established refrigerant property database.

10. REFERENCES

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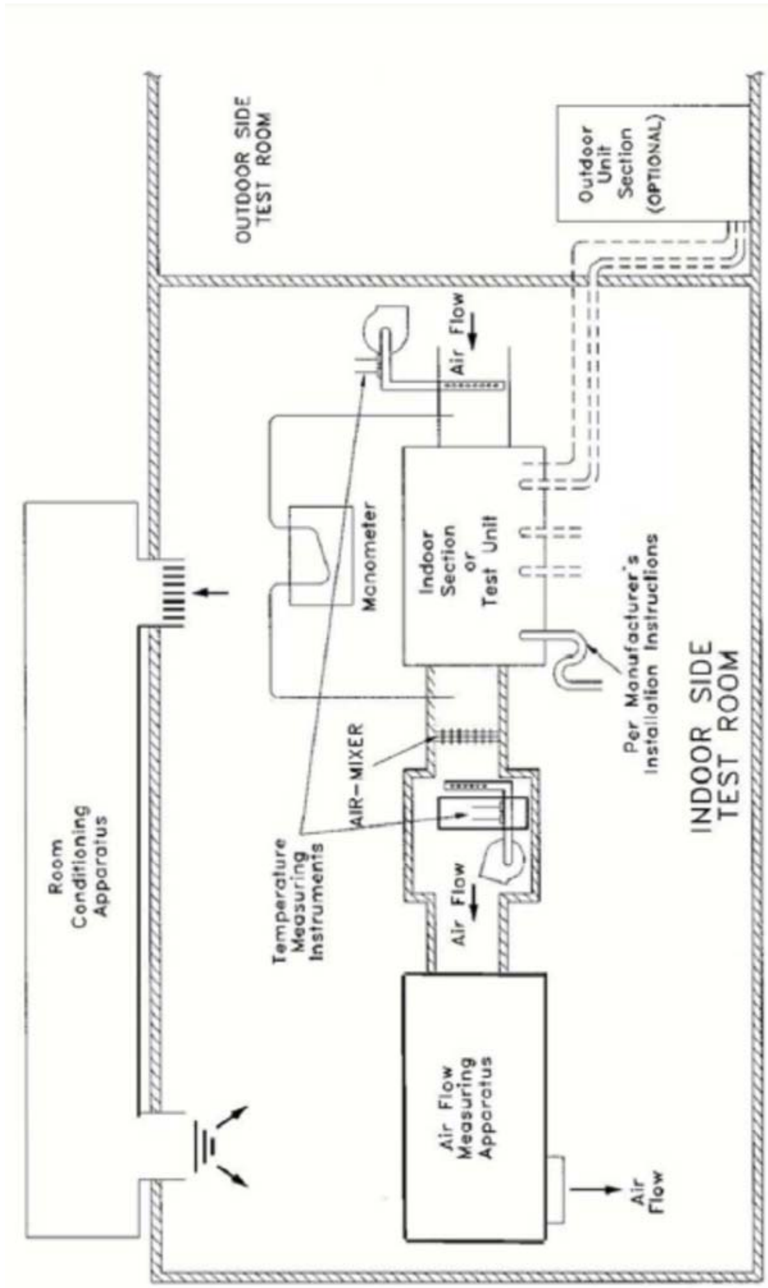

Figure 1 Tunnel air enthalpy test method arrangement.

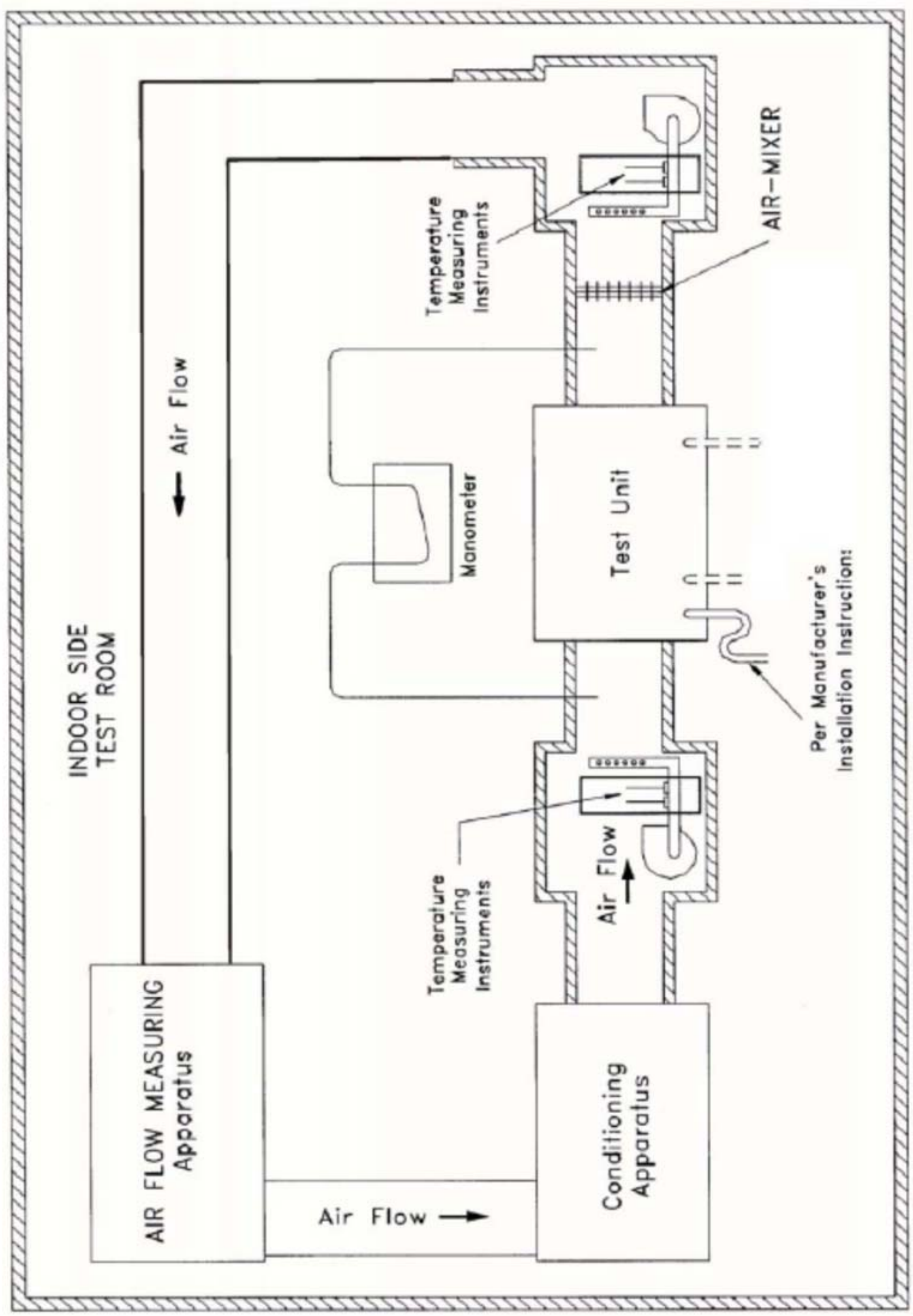

Figure 2 Loop air enthalpy test method arrangement.

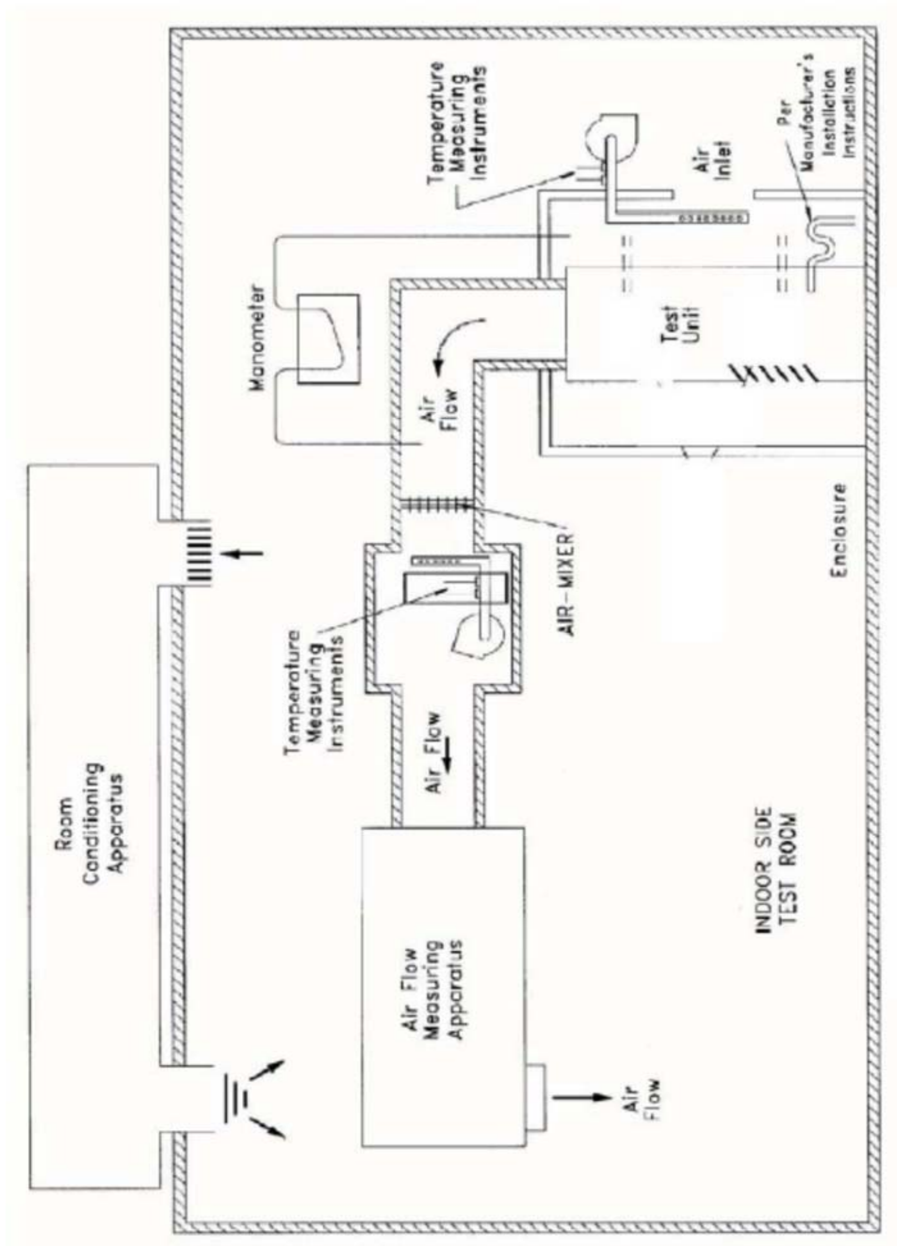

Figure 3 Calorimeter air enthalpy test method arrangement.

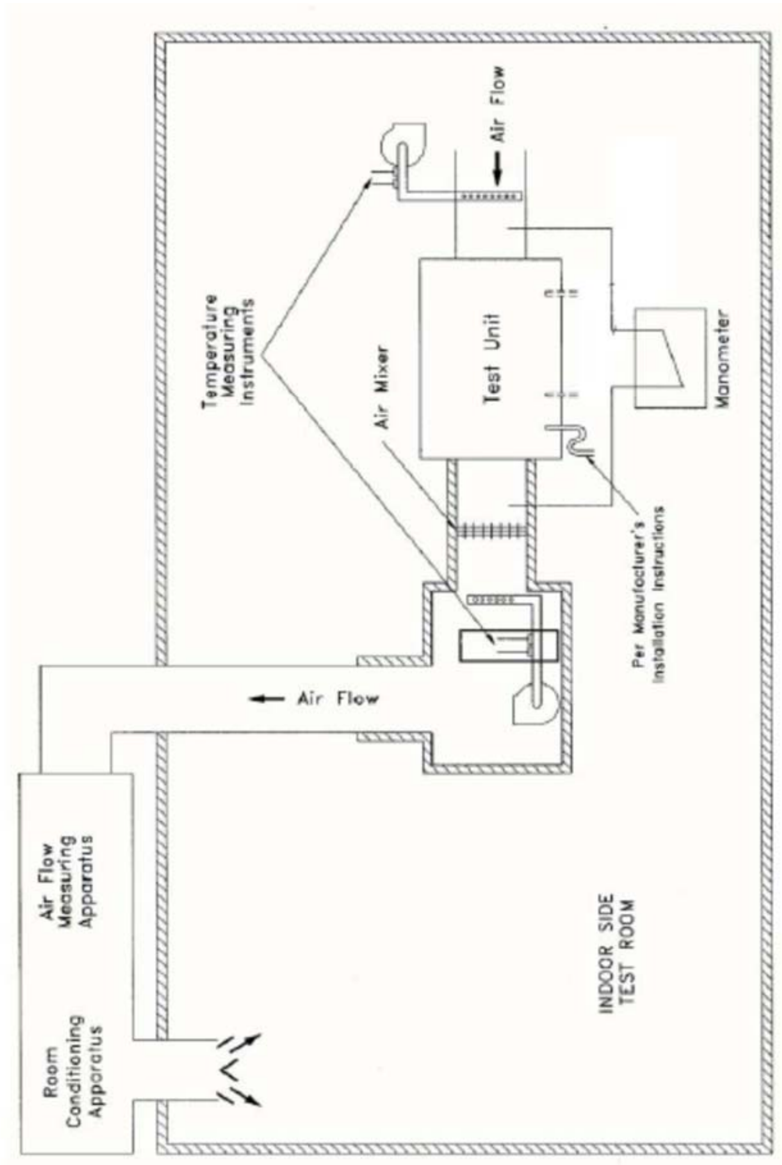

Figure 4 Room-air enthalpy test method arrangement.

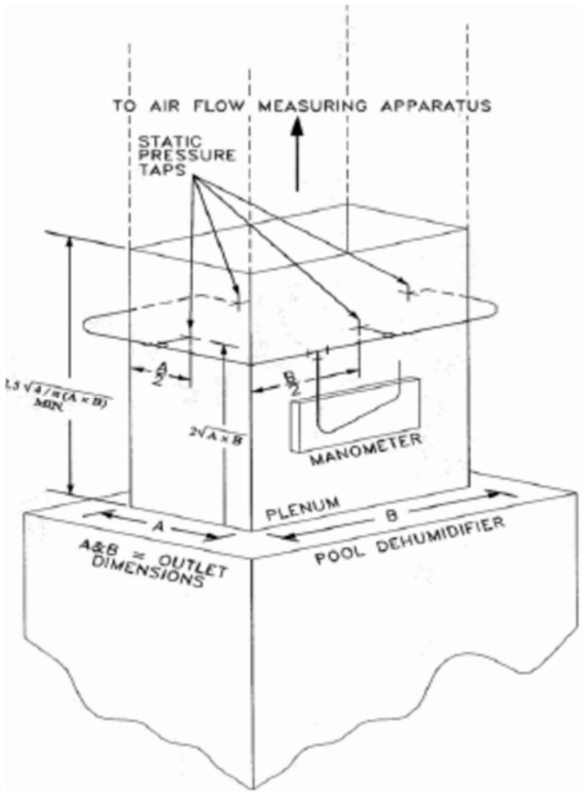

Figure 5 External static-pressure measurement.

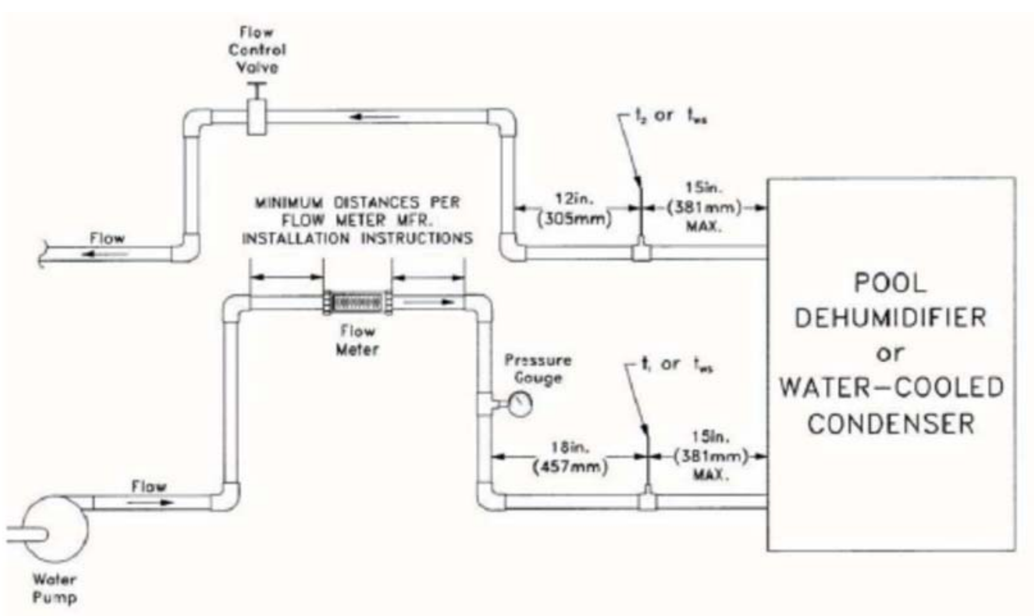

Figure 6 Plumbing layout and location of water temperature measurements.