



BSR/ASHRAE Standard 164.1-2012R

Public Review Draft

Method of Test for Residential Central-System Humidifiers

**First Public Review (November 2024)
(Complete Draft for Full Review)**

This draft has been recommended for public review by the responsible project committee. To submit a comment on this proposed standard, go to the ASHRAE website at www.ashrae.org/standards-research--technology/public-review-drafts and access the online comment database. The draft is subject to modification until it is approved for publication by the Board of Directors and ANSI. Until this time, the current edition of the standard (as modified by any published addenda on the ASHRAE website) remains in effect. The current edition of any standard may be purchased from the ASHRAE Online Store at www.ashrae.org/bookstore or by calling 404-636-8400 or 1-800-727-4723 (for orders in the U.S. or Canada).

The appearance of any technical data or editorial material in this public review document does not constitute endorsement, warranty, or guaranty by ASHRAE of any product, service, process, procedure, or design, and ASHARE expressly disclaims such.

© 2024 ASHRAE. This draft is covered under ASHRAE copyright. Permission to reproduce or redistribute all or any part of this document must be obtained from the ASHRAE Manager of Standards, 180 Technology Parkway, Peachtree Corners, GA 30092. Phone: 404-636-8400, Ext. 1125. Fax: 404-321-5478. E-mail: standards.section@ashrae.org.

ASHRAE, 180 Technology Parkway, Peachtree Corners, GA 30092

(This foreword 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.)

FOREWORD

This standard provides rules for the testing of central-system humidifiers for residential applications. Its purpose is to provide a uniform method for testing in a laboratory environment. Although the method of test originated in AHRI Standard 610, Performance Rating of Central System Humidifiers, the project committee has developed this separate method of test to be used independently of the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) rating standard so that manufacturers, specifiers, installers, and users of central-system residential humidifiers can test a humidifier's capacity under a variety of conditions with uniform results. This method of test was prepared in cooperation with AHRI to correspond with AHRI Standard 610.

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 guidelines throughout the industry. This standard has been harmonized with ASHRAE Standard 91 series which removed most calculations. This also is harmonized with AHRI 610. This version was updated for additional clarity on installation arrangements.

Standard 164.1 is the first in a series of four standards for the testing of humidifiers. Standard 164.2 addresses self-contained humidifiers for residential applications, Standard 164.3 addresses commercial and industrial isothermal humidifiers, and Standard 164.4 addresses commercial adiabatic humidifiers.

1. PURPOSE

This standard establishes a uniform method of laboratory testing for rating central-system residential humidifiers.

2. SCOPE

2.1 The scope of this standard covers a method of test for measuring the humidification rate of central-system residential humidifiers intended for use with forced-warm-air heating/cooling systems.

2.2 This method of test describes the test apparatus, mode of test conduction, and information to be recorded.

2.3 Tests covered include methods for measuring electrical power input, water flow rate, water temperature, and water pressure to the test humidifier. Included are airflow rate, static pressure, temperature, and relative humidity entering and maintained by the test apparatus.

2.4 Information resulting from the application of this test method is intended for use by manufacturers, specifiers, installers, and users of central-system residential humidifiers.

2.5 This test method does not apply to self-contained humidifiers, portable humidifiers, or humidifiers for commercial and industrial applications.

3. DEFINITIONS

central-system humidifier: a humidifier installed in, or discharges into, the airstream of an HVAC system.

chronometer: a timepiece that displays time in seconds and keeps time to the required accuracy

humidification rate: a measure of the ability of a humidifier to add moisture to its surrounding atmosphere, expressed as kg (lb_m) of water evaporated per unit of time.

humidifier: a device designed to add moisture to air.

heating or cooling unit: the unit that the humidifier is connected to or mounted within.

portable humidifier: a type of humidifier that has the characteristics described in AHAM-HU-1, *Household Humidifiers*.¹

return duct humidifier: a humidifier connected to a horizontal duct and that has the function of returning humidified air to the central system.

return plenum central-system humidifier: a humidifier connected to a vertical duct and has the function of returning humidified air to the central system.

room airflow: air introduced into a conditioned space to obtain a desired indoor atmospheric environment.

self-contained humidifier: a humidifier that adds moisture to the air without the need of other mechanical devices and is not connected to the central heating/ventilation system.

must: the word *must* indicates requirements of this standard.

supply duct central-system humidifier: a humidifier connected to a horizontal duct and has the function of delivering humidified air from the central system.

supply plenum central-system humidifier: a humidifier connected to a vertical duct and has the function of delivering humidified air from the central system.

4 SYMBOLS AND SUBSCRIPTS

A_t	=	cross-sectional area of a test section, m ² (ft ²)
D	=	duct diameter, m (ft)
H_X	=	weight of water at time X, kg (lb _m)
H_m	=	humidification rate, kg/h (lb _m /h)
M	=	diameter of round duct or equivalent diameter of rectangular duct, m (ft)
M_{wf}	=	final weight of water, kg (lb _m)
M_{wi}	=	initial weight of water, kg (lb _m)
P	=	static pressure at nozzle, plane N, kPa (in. Hg)
p_b	=	total pressure at the nozzle, kPa (in. Hg)
p	=	atmospheric pressure, kPa (in. Hg)
Q_x	=	airflow rate at plane x, m ³ /s (cfm)
Q_{std}	=	airflow flow rate of standard air m ³ /s (cfm)
t_{dx}	=	dry-bulb temperature at plane x, °C (°F)
t_{wx}	=	wet-bulb temperature at plane x, °C (°F)
V_x	=	air velocity at plane x, m/s (fpm)
W	=	total power, Watts
ΔP_{xN}	=	pressure differential of a nozzle, Pa (in. w.g.)
ΔP_x	=	pressure differential across plane x, Pa (in. w.g.)
ΔP_{std}	=	pressure differential corrected to standard air, Pa (in. w.g.)
Σ	=	summation sign, dimensionless

4.1 Subscripts

f	=	final
i	=	initial
N	=	nozzle
m	=	mass
std	=	standard
w	=	water

Numerical subscripts are used to define the following locations:

N1	=	entering the nozzle
N2	=	leaving the nozzle

- 1 = measurements taken at Plane 1
- 2 = measurements taken at Plane 2

5 INSTRUMENTS AND MEASUREMENT METHODS

5.1 Instrument Calibrations. Measurements from the instruments must be traceable to primary or secondary standards calibrated by the National Institute of Standards and Technology (NIST) or to the Bureau International des Poids et Mesures (BIPM) if a National Metrology Institute (NMI) other than NIST is used. In either case, the indicated corrections must be applied to meet the uncertainty stated in subsequent sections. Instruments must be recalibrated on regular intervals that do not exceed the intervals prescribed by the instrument manufacturer, and calibration records must be maintained. Instruments must be installed in accordance with the instrument manufacturer’s requirements. If not, the manufacturer’s accuracy must not apply.

5.2 Instrument Accuracy Requirements and Measurement Methods. Measuring instruments must be selected to meet or exceed the instrument accuracy listed in Table 1 for each type of measurement. Instruments and measurement methods must comply with the ASHRAE measurement standards listed in Table 1.

TABLE 1: Test instrument requirements and measurement methods

Measurement Parameter	Accuracy	Maximum Resolution	ASHRAE Standard
Air dry-bulb temperature	±1.0°C (±0.5°F)	±1.0°C (±0.5°F)	41.1 ²
Air wet-bulb temperature	±1.0°C (±0.5°F)	1.0°C (0.5°F)	41.6 ³
Water temperature	±0.5°C (±1.0°F)	0.5°C (1.0°F)	N/A
Other temperatures	±0.3°C (±0.5°F)	0.1°C (0.2°F)	41.1 ²
Barometric pressure	±34 Pa (±0.01 in. Hg)	2 Pa (0.005 in. Hg)	41.3 ⁴
Room Airflow	±5.0 percent of reading	±2.5 percent of reading	41.2 ⁷
Water Pressure	±8.0 percent of reading	±0.5 percent of reading	41.3 ⁴
Other pressures	±1.0 percent of reading	±0.5 percent of reading	41.3 ⁴
Weight	±0.0045 kg (0.01 lb)	±0.5 percent of reading	N/A
Power	±1.0 percent of reading	±0.5 percent of reading	41.11 ⁵
Time	±0.5% of the elapsed time measured	±0.1% of the elapsed time measured	N/A

5.3 Airflow Measurement. For humidifiers to be installed within an air duct, apply ASHRAE Standard 41.2² to measure volumetric airflow and standard volumetric airflow using a single- or multiple-nozzle test chamber.

Room airflow must be measured within 1.5 m (5 ft) of the humidifier.

5.4 Static Pressure Measurement in Ducts or Chambers. Static pressure in ducts or chambers must be measured in accordance with the static pressure tap geometry and the piezometer ring specifications in Section 8 of ASHRAE Standard 41.2²

5.5 Air Temperature. Both wet- and dry-bulb air temperatures must be measured in accordance with ASHRAE Standard 41.6³. An air sampling apparatus and a wet-bulb psychrometer is illustrated in Figure 1.

5.5.1 If the wet-bulb psychrometer is designed in accordance with Section 7.1 of ASHRAE Standard 41.6³, the wet-bulb temperatures must be read only when the air velocity is 3.56±0.18 m/s (700±50 ft/min) over the wet-bulb sensor and only when evaporative equilibrium of the sensor has been attained.

5.5.2 If the wet-bulb psychrometer is not designed in accordance with Section 7.1 of ASHRAE Standard 41.6³, the wet-bulb temperatures must be read only when the air velocity is 3.56 to 10 m/s (700 to 2000 ft/min) over the

wet-bulb sensor, and only when evaporative equilibrium of the sensor has been attained.

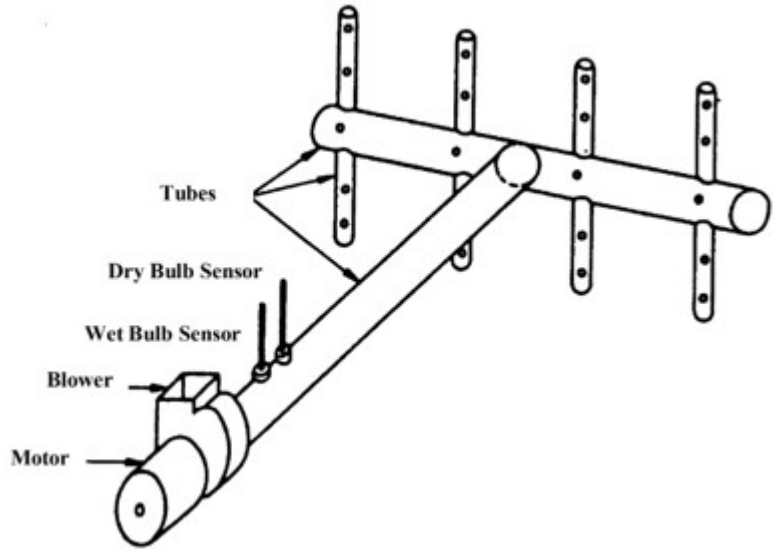


FIGURE 1 Example of an airflow sampling tree assembly that includes a wet-bulb psychrometer. The sample tree must sample at least nine equal areas.

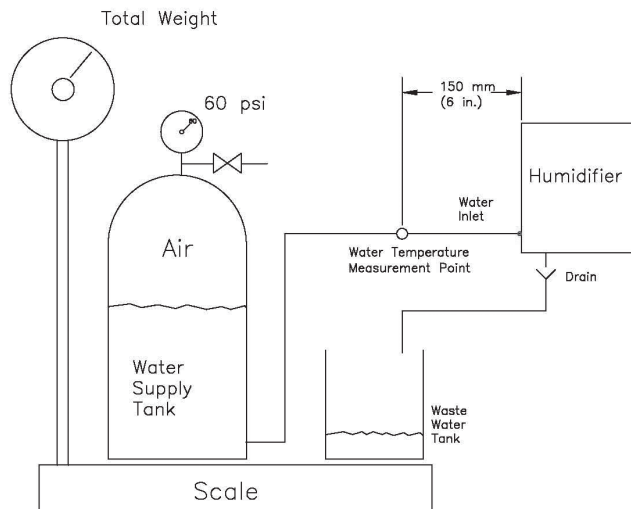
5.6 Water Temperature. Methods of measuring water temperature include a submerged well, an insulated wrap of the supply line, or other methods.

5.7 Air Density. Air density must be calculated from measurements of wet-bulb temperature, dry-bulb temperature, and atmospheric pressure or other parameters for air density calculation if the maximum error in the calculated density does not exceed $\pm 0.5\%$.

5.8 Watt Meters. Power must be measured using a watt meter connected to the humidifier over the duration of the test in accordance with ASHRAE Standard 41.11⁵.

5.9 Water Flow

5.9.1 Scale and Weigh Tanks. Water flow must be measured using a scale, a pressurized water supply tank to the humidifier, and a wastewater tank, as shown in Figure 2. A chronometer must be used to determine the rate of water flow.



Informative Note: Total weight = Water supply for the humidifier + water sent to the water waste tank. Water evaporated = weight from end of the test (H_2) - weight from the start of the test (H_1)

Figure 2 Scale and weigh tanks.

6 EQUIPMENT AND SETUP

6.1 Setup. The setup of the testing equipment must be defined by Table 2 and illustrated in Figures 3 to 7.

TABLE 2: Test setup by arrangement

Designation	Arrangement			Figure
	First component	Second component	Third component	
Return Air Duct (RD)	Horizontal duct - returning air to central air system	Humidifier	Central air system	7
Return Air Plenum (RP)	Vertical duct - returning air to central air system	Humidifier	Central air system	6
Supply Air Duct (SD)	Central air system	Humidifier	Horizontal duct - returning air to central air system	7
Supply Air Plenum (SP)	Central air system	Humidifier	Vertical duct - returning air to central air system	4
By-pass (Supply-to-Return) (SR)	Horizontal / vertical duct - returning air to central air system	Humidifier	Horizontal /vertical duct - delivering air from central air system to return plenum	5

6.2 Air Volume Measuring Apparatus for Air Distribution. Apply ASHRAE Standard 41.2² to measure volumetric airflow and standard volumetric airflow using a single- or multiple-nozzle test chamber.

Accurate, precise measurement of air volume is necessary for the testing of humidifiers that are part of an air distribution system. The humidifier itself exerts no control over the air volume circulated through the duct system, yet the performance of certain types of furnace- and duct-mounted humidifiers is substantially affected by air velocity within the system. Air volume measuring apparatus must be constructed as described in this method of test.

6.2.1 Flow Nozzle Apparatus. The apparatus described in ASHRAE Standard 41.2² must be used to measure airflow rates. The apparatus basically consists of a receiving chamber, one or more flow nozzles installed in a nozzle plate, a discharge chamber, a fan, and an attached duct for connecting the air-measuring section to other sections of the test apparatus.

Informative Note: A receiving chamber is optional as a part of the apparatus. The air-measuring section for the distribution system is illustrated in Figure 3. If there is an elbow directly after the airflow measurement station, there must be turning vanes.

6.2.2 Receiving Chamber. When air flows from the room or a preconditioner into the receiving chamber, an air preconditioner must be used to satisfy the dry-bulb and wet-bulb temperature requirements for the test. The receiving chamber is shown in Figure 3.

The dimension *M* in Figure 3 is the inside diameter of a circular chamber or the equivalent diameter of a rectangular chamber with inside transverse dimensions *a* and *b*, where

$$M = (4a \times b / \pi)^{1/2} \quad (1)$$

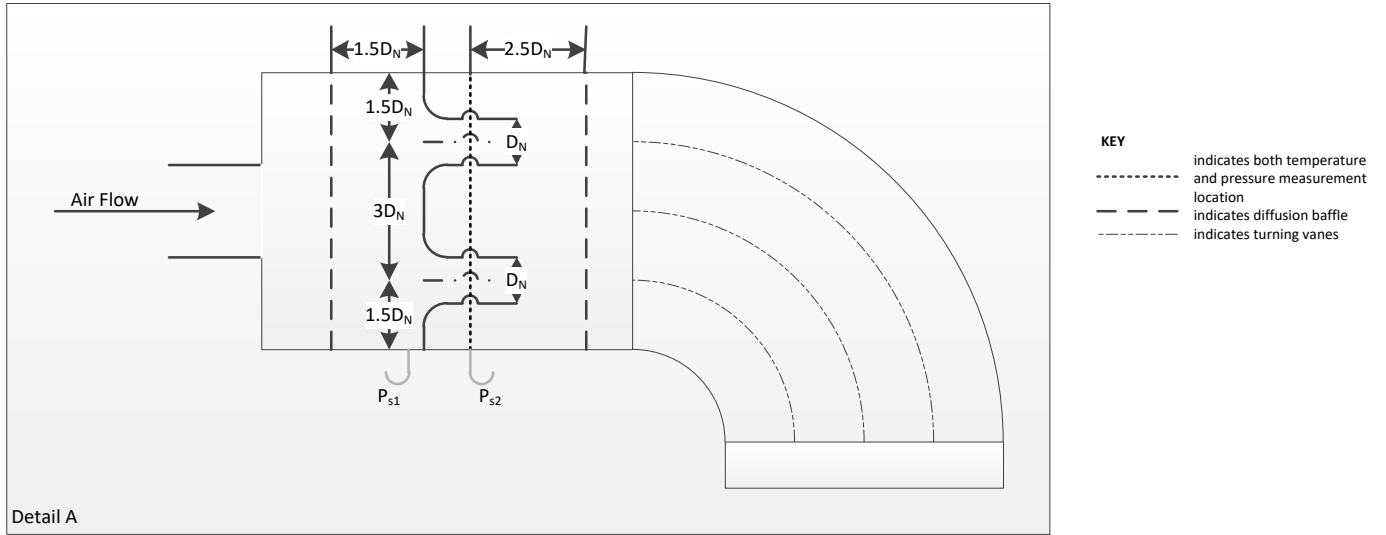


Figure 3. Airflow-measuring station

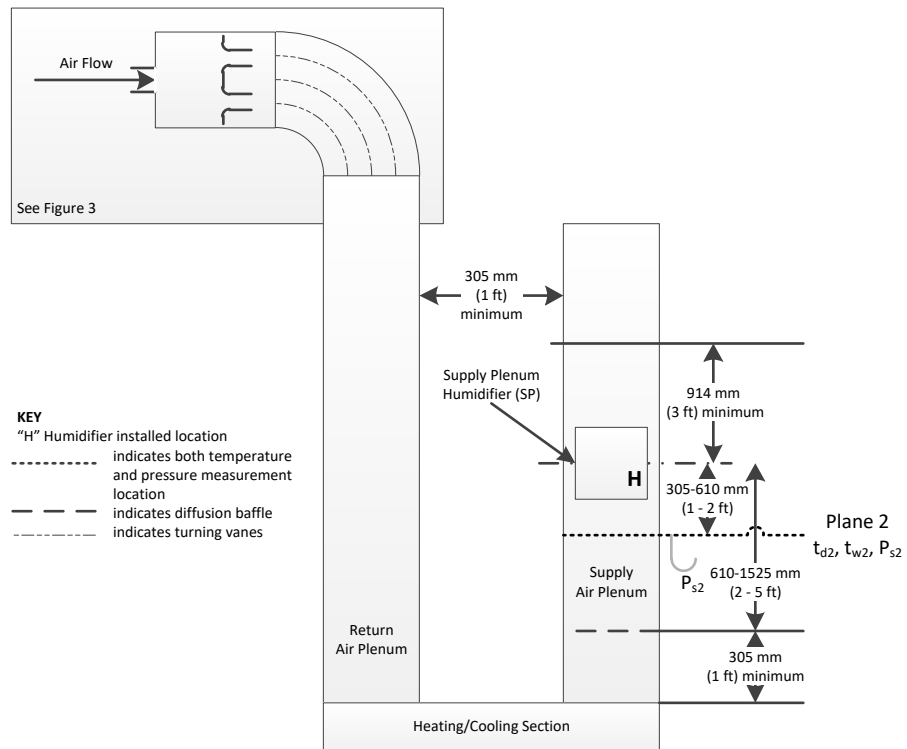


Figure 4. Supply Plenum Humidifier (SP) Test Setup

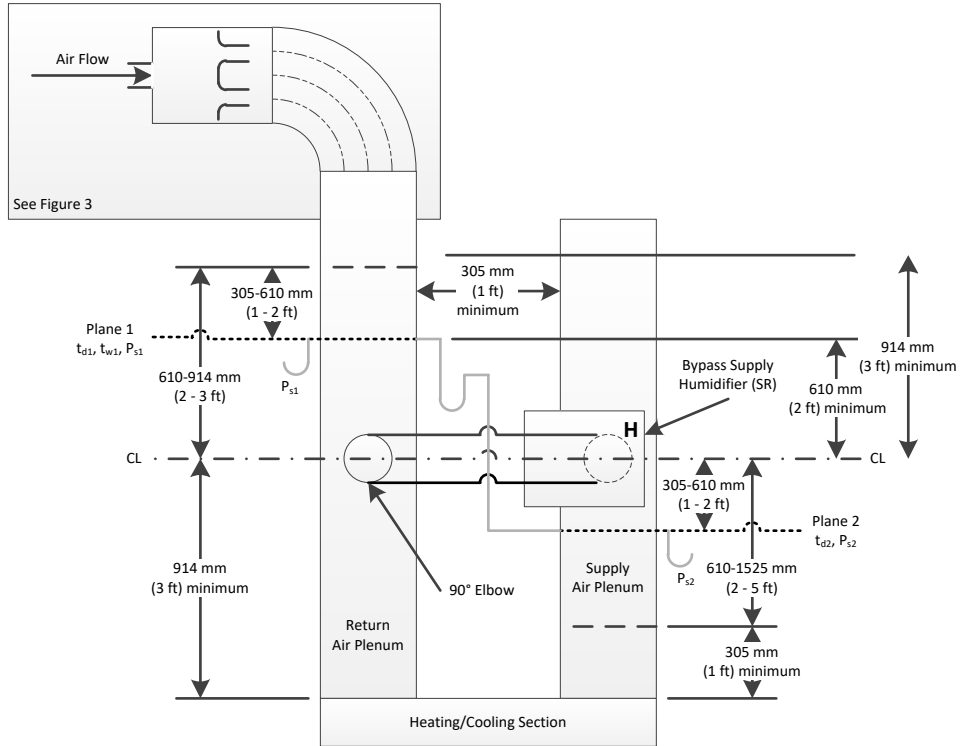


Figure 5. Bypass Humidifier (SR) Test Setup

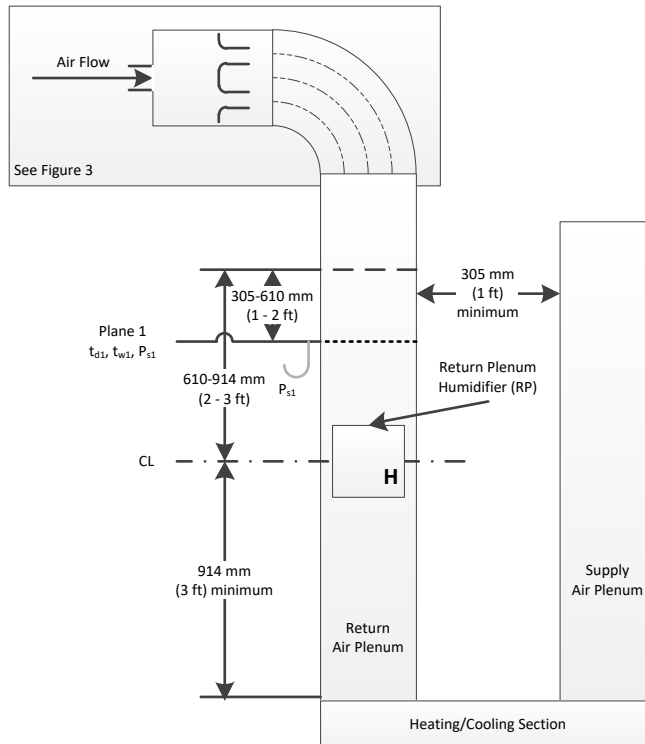


Figure 6. Return Plenum Humidifier (RP) Test Setup

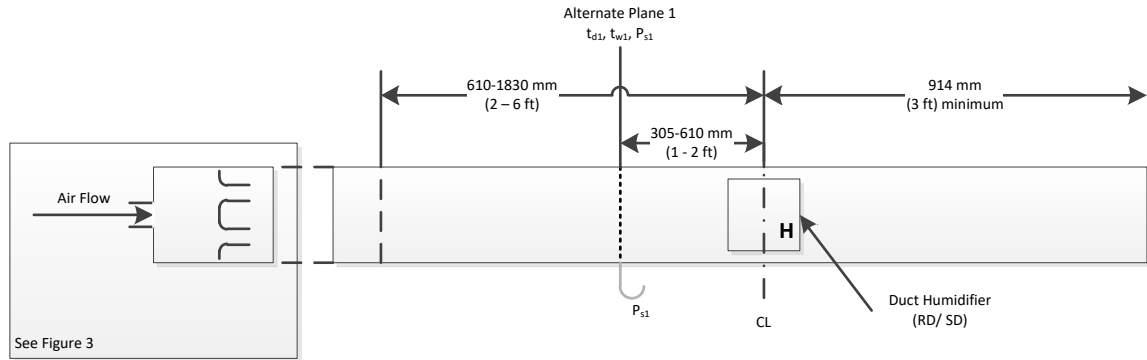


Figure 7. Duct Humidifier (SD/RD) Test Setup

6.3 Connections to Other Sections of Apparatus. Ductwork must be used to connect the air-measuring section with other sections of the apparatus. All joints and seams in the connecting ducts and between the connecting ducts and adjoining sections of apparatus must be sealed using tape or other sealant so the entire apparatus achieves an air tightness class of C in accordance with Standard EN 12237⁸ or 1507⁹. Special attention must be paid to sealing the heating unit of the heating section to prevent air leakage.

6.4 Air Treatment Apparatus. Each test apparatus must be provided with air-treating equipment to maintain the prescribed conditions of temperature, humidity, and pressure of the air entering the humidifier test section.

6.5 Temperature-Measuring Apparatus. Air temperature measurements in ducts and fluid temperature measurements within conduits must be made in accordance with the applicable provisions of ASHRAE Standards 41.1², or 41.6³, except where the specific requirements of Section 5.5 apply.

6.5.1 Air Mixers. Mixing with mixers or other types of devices must be used to provide uniform temperature profiles to the humidifier and measurement devices in accordance with ASHRAE Standard 41.1.²

6.6 Water-Measuring Apparatus. Means must be provided to measure the amount of water evaporated by the humidifier under test, as prescribed in Section 5.9.

6.7 Humidifier Test Sections

6.7.1 Single Duct or Plenum Test Sections. Each single duct or plenum test section must contain a settling means and an airflow straightener to ensure uniform air velocity and temperature within the test section. If two or more humidifier test sections are in series, the transition and turning fittings connecting the test sections must be designed to minimize disturbances in the airstream. Low impact transition and turning fittings must be used to connect a humidifier test section to an air-measuring section, heating unit, or other apparatus.

6.7.1.1 Supply or Return Duct Test Section. The supply or return duct test section must be constructed as shown in Figure 7. It must consist of a horizontal, rectangular duct with internal dimensions of $305 \times 710 \pm 6$ mm ($12 \times 28 \pm 0.25$ in.).

6.7.2 Supply-to-Return Test Section. The supply-to-return test section must be constructed as shown in Figure 5 and must consist of two parts: the return plenum and the supply plenum.

6.7.2.1 Return Plenum. The return plenum must consist of a rectangular duct having internal dimensions of $305 \times 710 \pm 6$ mm ($12 \times 28 \pm 0.25$ in.).

6.7.2.2 Supply Plenum. The supply plenum must consist of a rectangular duct having internal dimensions of $305 \times 710 \pm 6$ mm ($12 \times 28 \pm 0.25$ in.).

6.7.2.3 Uniform Size. The two plenums must be uniform in cross section and of equal cross-sectional area. Diverters, plates, or air-directing devices, other than those supplied with the humidifier by the manufacturer, must not be used to direct air at a higher-than-average velocity either toward or away from the humidifier under test.

6.7.3 Heating Unit Test Section. The heating unit test section must consist of three parts: the return plenum, the supply plenum, and the specific heating unit. The humidifier must be installed, connected to, or mounted within this unit in accordance with the manufacturer's written instructions.

7 OBSERVATIONS AND CONDUCT OF TEST

7.1 Test Methods. The test methods described are as listed below:

- a. Return Duct Test Method (See Section 7.2.2)
- b. Return Plenum Test Method (See Section 7.2.5)
- c. Supply Duct Test Method (See Section 7.2.2)
- d. Supply Plenum Test Method (See Section 7.2.3)
- e. Supply-to-Return Test Method (See Section 7.2.4)

7.1.1 Applicability of Test Methods. Humidifying equipment must be tested using the test method that conforms to the installation method or installation location specified by the manufacturer's installation instructions.

7.1.1.1 Multiple Testing. When more than one installation method or installation location is specified by the manufacturer, it is permissible to test the humidifier using more than one test method listed in Section 7.1. The additional test method used must be a test method that conforms to the manufacturer's alternative installation method or installation location.

7.2 Test Requirements. See Figure 3 for the location of planes.

7.2.1 Test conditions for all testing methods must comply with the next six sections and Table 3

7.2.1.1 Air Velocity. The air velocity in the supply plenum must occur as a result of maintaining the specified air velocity in the return plenum. This air velocity must be uniform. Diverters, plates, or air-directing devices, other than those supplied with the humidifier by the manufacturer, must not be used to direct air at a higher- than-average velocity either toward or away from the humidifier under test.

Informative Note: Lower velocities recommended by the manufacturer. The air velocity in the return plenum or return duct must be maintained per Table 3. The air velocity must be uniform, having a tolerance of $\pm 2.5\%$. Diverters, plates, or air-directing devices, other than those supplied with the humidifier by the manufacturer, must not be used to direct air at a higher-than-average velocity either toward or away from the humidifier under test.

7.2.1.2 Cross-Sectional Area. The cross-sectional area used for the velocity calculation must be the cross-sectional area of the humidifier test section measured 305 mm (12 in.) upstream of the test unit and perpendicular to the direction of airflow.

7.2.1.3 Water Supply. The water supply source must be directly connected to the humidifier, and the water control device on the humidifier must regulate the water flow rate. The pressure and temperature of the feed water entering the water control device must be per Table 3.

7.2.1.4 Air Temperature and Pressure. The dry-bulb and wet-bulb temperature at the air-volume-measuring station, plane N1, must be per Table 3. The air pressure in the test plenum, plane 1 or 2, as appropriate, must be per Table 3.

7.2.1.5 Heating Section. A heating device must be located between the return air plenum and the supply air plenum of the humidifier test section. The device must be controlled in so that the dry-bulb temperature of the air entering the supply plenum of the humidifier test section is per Table 3 during the test.

7.2.1.6 Electrical Supply. Humidifiers that require electrical energy for operation must be connected to a supply of the specified voltage and frequency. Voltage and frequency must be measured and recorded at the power input terminals of the humidifier. A watt meter must be installed in the electrical circuit when a humidifier is connected to an electrical supply circuit. Voltage tolerances on voltage must be held within $\pm 1\%$ throughout the test.

TABLE 3: Test Conditions

Measurement Parameter	Measurement Location	Test Value	Accuracy
Air velocity	Return plenum or return duct	4.0 m/s (800 fpm)	±0.1 m/s (±20 fpm)
Air dry-bulb temperature	Return plenum or return duct	23.9 °C (75 °F)	±0.5°C (±1.0°F)
	Air-volume-measuring station, plane N1	23.9 °C (75 °F)	±0.5°C (±1.0°F)
Air wet-bulb temperature	Return plenum or return duct	13.6 °C (56.5 °F)	±0.5°C (±1.0°F)
	Air-volume-measuring station, plane N1	13.6 °C (56.5 °F)	±0.5°C (±1.0°F)
Water pressure	Water supply	410 kPa (60 psi)	±35 kPa (±5 psi)
Water temperature	Water supply	10 to 16 °C (50 to 61 °F)	±0.5°C (±1.0°F)
Air pressure	Test plenum, plane 1 or 2	7.5 Pa (0.03 in. w.g.)	±2.5 Pa (±0.01 in. w.g.)
Air dry-bulb temperature	Supply plenum	Test Value	±1.1°C (±2.0°F)
Voltage	Humidifier voltage	Test Value	±1%

7.2.2 Supply Duct and Return Duct Test Method. Supply duct and return duct test methods described in this section are used to determine the humidification capacity of equipment that is installed in the horizontal duct system of a warm-air heating installation. The humidification equipment must be installed in the humidifier test section in such a way that it complies with the manufacturer’s written instructions.

7.2.2.1 Test Apparatus. The test apparatus is composed of the following components:

- a. Air-Volume-Measuring Apparatus (Section 6.2)
- b. Air-Treatment Apparatus (Section 6.4)
- c. Temperature-Measuring Apparatus (Section 6.5)
- d. Water-Measuring Apparatus (Section 6.6)
- e. Humidifier Test Sections (Figure 7)
- f. Heating Section

7.2.3 Supply Plenum Test Method. The test method described in this section must be used to determine the humidification capacity of the equipment that is installed in the supply plenum air duct system of a warm-air heating installation. The humidification equipment must be installed in the humidifier test section in such a way that it complies with the manufacturer’s written instructions, except as otherwise provided in this standard.

7.2.3.1 Test Apparatus. The test apparatus is composed of the following components:

- a. Air-Volume-Measuring Apparatus (Section 6.2)
- b. Air-Treatment Apparatus (Section 6.4)
- c. Temperature-Measuring Apparatus (Section 6.5)
- d. Water-Measuring Apparatus (Section 6.6)
- e. Humidifier Test Section (Figure 4)
- f. Heating Section

7.2.4 Supply-to-Return Test Method. The test method described in this section is used to determine the humidification capacity and airflow of equipment that is installed between the supply and return plenums or ducts of a warm-air furnace. This equipment is described as a “differential static-pressure wetted surface” humidifier. The humidification equipment must be installed in the humidifier test section in such a way that it complies with the manufacturer’s written instructions and otherwise conforms to the following provisions:

- a. The test installation must simulate a differential static-pressure wetted surface” humidifier used in a basement-

type duct system installed with the return air plenum conveying air vertically downward and the supply plenum conveying air vertically upward.

- b. The humidifier under test must be mounted on either the supply air plenum or the return air plenum.
- c. The surfaces of the supply and return plenums that are connected to the humidifier must be parallel and facing in the same direction (see Figure 5).
- d. The humidifier under test must be installed in such a way that the air passing through the humidifier makes at least one 90 degree turn external to the humidifier. If the required duct sections and fittings are accessory items furnished with the humidifiers, these duct sections and fittings must be used to make the 90 degree turn external to the humidifier.

7.2.4.1 Test Apparatus. The test apparatus is composed of the following components:

- a. Air-Volume-Measuring Apparatus for Air Distribution (Section 6.2)
- b. Air-Treatment Apparatus (Section 6.4)
- c. Temperature-Measuring Apparatus (Section 6.5)
- d. Water-Measuring Apparatus (Section 6.6)
- e. Humidifier Test Sections (Figure 5)
- f. Heating Section

7.2.5 Return Plenum Test Method. The test method described in this section must be used to determine the humidification capacity of the equipment that is installed in the return air plenum duct system of a warm-air heating installation. The humidification equipment must be installed in the humidifier test section in such a way that it complies with the manufacturer's written instructions, except as otherwise provided in this standard.

7.2.5.1 Test Apparatus. The test apparatus is composed of the following components:

- a. Air-Volume-Measuring Apparatus (Section 6.2)
- b. Air-Treatment Apparatus (Section 6.4)
- c. Temperature-Measuring Apparatus (Section 6.5)
- d. Water-Measuring Apparatus (Section 6.6)
- e. Humidifier Test Section (Figure 6)
- f. Heating Section

7.2.6 Heating Unit Test Method. The test method described in this section is used to determine the humidification capacity of equipment connected to, or mounted within, the heating or cooling unit. The humidification equipment must be installed in the unit in such a way that complies with the manufacturer's written instructions.

7.3 Performance of Test. The humidifier to be tested must be installed in the appropriate test section as described in Sections 7 and 8.

7.3.1 Connection for Capacity Test. The humidifier under test must be connected to the water-supply-measuring apparatus described in Section 6.6.

- a. Humidifiers with a float or balanced pan valve must be adjusted according to the manufacturer's written instructions.
- b. Humidifiers with an electric water valve must be adjusted according to the manufacturer's written instructions.

7.3.2 Data to be Recorded. All data required to determine the humidifying capacity of the unit must be recorded as appropriate to the type of humidifier and the test apparatus used.

7.3.2.1 Air Temperatures. Dry-bulb and wet-bulb temperatures must be observed and recorded at the following locations:

- a. Air temperature entering flow nozzles, plane N1: dry-bulb and wet-bulb, °C (°F).
- b. Air temperature entering return duct or return plenum or return side of supply-to-return humidifier test section: dry-

bulb only, °C (°F), for plane 1 or 2.

- c. Air temperature entering supply plenum, supply duct, or supply side of supply-to-return humidifier test section: dry-bulb only, °C (°F), for plane 1, 2, or 3, as appropriate

7.3.2.2 Air Pressures. Air pressures must be observed and recorded at the following locations to determine differential pressure:

- a. Static pressure differential drop across flow nozzle: plane N, Pa (in. w.g.);
- b. Static pressure of air entering flow nozzle: plane N1, Pa (in. w.g.)
- c. Pressure in return duct or return plenum humidifier test section: plane 1, Pa (in. w.g.), column below atmospheric pressure
- d. Pressure in supply duct or supply plenum humidifier test section, plane 2, Pa (in. w.g.), column above atmospheric pressure
- e. Pressure in supply-to-return humidifier test apparatus,

Δ Pa (in. w.g.): pressure difference between supply plenum and return plenum with supply plenum pressure being greater than return plenum pressure (plane 1 minus plane 2)

- f. Atmospheric pressure, kPa (in. Hg), taken in the test area.

7.3.2.3 Water Temperature and Pressure. Water temperature and pressure must be observed and recorded as follows:

- a. Water temperature entering and leaving the humidifier, °C (°F)
- b. Water pressure during testing or during preliminary water adjustment, kPa (psi)

7.3.2.4 Water Quantity. Weights or volumes of water consumed during a test run must be observed and recorded as follows:

- a. Weight of water in tanks at the beginning of the test, H_1 kg (lb_m)
- b. Weight of water in tanks at the end of the test, H_2 kg (lb_m)

7.3.2.5 Time. The time of each reading and the elapsed time between successive readings of all data must be recorded in 60 +/- 3 seconds intervals.

7.3.2.6 Electrical Power Input. Power input (including transformers) must be recorded in watt-hours at a time when solenoids, heaters, and other appurtenances are operating.

7.3.3 Procedure. After the prescribed conditions of the test have been attained, at least five readings must be taken over equal time intervals. The duration of time between readings must be not less than 15 min. The test must be continued until the variation in humidification rate is $\pm 5\%$ or less for four successive readings.

7.3.4 Humidification Rate. The water evaporated by the humidifier under test must be determined using Equation 18 and must be the average of successive test readings complying with this section.

8 CALCULATIONS

8.1 Calibration Correction. Calibration corrections, when required, must be applied to individual readings before averaging or other calculations. Calibration corrections are not required if the correction is smaller than one half the maximum allowable error specified for each instrument.

8.2 Standard Airflow Rate. Apply ASHRAE Standard 41.2 to calculate the standard volumetric airflow rate Q_{std} , m^3/s (cfm)

8.3 Power Input at Test Conditions. The total power input to the test unit is the sum of fan and pump or rotary device power and appurtenance device power.

$$W_{total} = WF_E + WF_L + W_{ex} + W_E + W_L \quad W \text{ (W)SI/IP} \quad (17)$$

8.4 Humidification Rate H_M kg/h (lb_M/h)

$$H_M = (H_i - H_f) / \text{Time elapsed} \quad (18)$$

9 REPORT AND RESULTS OF TEST

9.1 Report. The report of a laboratory test must include:

- Objective of the test
- Results
- Test data
- Descriptions of the humidification unit, including the test setup and test instruments as outlined in Section 7.
- The laboratory must be identified by name and location.
- Performance data must be summarized in a table.

9.1.1 Identification. Performance sheets must list the test humidifier unit and test setup. Details must be listed to clearly identify the unit and setup.

10 REFERENCES

1. Herrmann, S., H.-J. Kretzschmar, and D.P. Gatley, ASHRAE RP-1485, Thermodynamic Properties of Real Moist Air, Dry Air, Steam, Water, and Ice, 2008, Atlanta: ASHRAE.
2. ANSI/ASHRAE Standard 41.1-2020, Standard Methods for Temperature Measurement, Atlanta: ASHRAE.
3. ANSI/ASHRAE Standard 41.6-2021 Standard Methods for Humidity Measurement, Atlanta: ASHRAE.
4. ANSI/ASHRAE Standard 41.3-2022, Standard Methods for Pressure Measurement, Atlanta: ASHRAE.
5. ANSI/ASHRAE Standard 41.11-2020, Standard Methods for Power Measurement, Atlanta: ASHRAE.
6. ANSI/ASHRAE Standard 41.8-2016 (R2019), Standard Methods for Liquid Flow Measurement, Atlanta: ASHRAE.
7. ANSI/ASHRAE Standard 41.2-2022, Standard Methods for Air Velocity and Airflow Measurement, Atlanta: ASHRAE.
8. EN Standard 12237, Ventilation for Buildings – Ductwork – Strength and leakage of circular sheet metal ducts
9. EN Standard 1507, Ventilation for Buildings – Sheet metal air ducts with rectangular section – Requirements for strength and leakage

INFORMATIVE APPENDIX A
INFORMATIVE REFERENCES AND BIBLIOGRAPHY

AHAM HU-1-2016, Portable Household Humidifiers. Washington, DC: Association of Home Appliance Manufacturers.

ASME Steam Properties. New York: American Society of Mechanical Engineers.

AHRI Standard 610-2014, *Performance Rating of Central System Humidifiers for Residential Applications*. Arlington, VA: Air Conditioning and Refrigeration Institute.