AHRI Standard 440 (I-P)

## 2019 Standard for

# Performance Rating of Fan-coil Units

AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

we make life better®

2311 Wilson Boulevard, Suite 400
Arlington, VA 22201, USA
www.ahrinet.org
PH 703.524.8800
FX 703.562.1942

**IMPORTANT**

***SAFETY DISCLAIMER***

AHRI does not set safety standards and does not certify or guarantee the safety of any products, components or systems designed, tested, rated, installed or operated in accordance with this standard/guideline. It is strongly recommended that products be designed, constructed, assembled, installed and operated in accordance with nationally recognized safety standards and code requirements appropriate for products covered by this standard/guideline.

AHRI uses its best efforts to develop standards/guidelines employing state-of-the-art and accepted industry practices. AHRI does not certify or guarantee that any tests conducted under its standards/guidelines will be non-hazardous or free from risk.

Note:

This standard supersedes ANSI/AHRI Standard 440-2008 with Addendum 1 and shall be effective January 1, 2020.

For SI ratings, see AHRI Standard 441 (SI)-2019.

**AHRI CERTIFICATION PROGRAM PROVISIONS**

**Scope of the Certification Program**

The current scope of the Room Fan-coil (RFC) Certification Program can be found on AHRI website www.ahrinet.org. The scope of the Certification Program should not be confused with the scope of the standard, as the standard also includes ratings for products that are not covered by a certification program.

Price $10.00 (M) $20.00 (NM)
Printed in U.S.A.

## TABLE OF CONTENTS



## TABLES



## APPENDICES



## TABLES FOR APPENDICES

## TABLE OF CONTENTS (CONTINUED)



## FIGURES FOR APPENDICES




Price $10.00 (M) $20.00 (NM)
Printed in U.S.A.

# PERFORMANCE RATING OF FAN-COIL UNITS

## Section 1. Purpose

**1.1** *Purpose*. The purpose of this standard is to provide for Fan-coil Units: definitions; test requirements; rating requirements; minimum data requirements for Published Ratings; operating requirements; marking and nameplate data; and conformance conditions.

**1.1.1** *Intent.* This standard is intended for the guidance of the industry, including manufacturers, engineers, installers, contractors and users.

**1.1.2** *Review and Amendment*. This standard is subject to review and amendment as technology advances.

## Section 2. Scope

**2.1** *Scope*. This standard applies to Fan-coil Units as defined in Section 3.16.

**2.2** *Exclusions*.

**2.2.1** This standard does not apply to Central-station Air-handling Units as defined in AHRI Standard 430.
**2.2.2** This standard does not apply to unit ventilator units as defined in AHRI Standard 840.
**2.2.3** This standard does not apply to Fan-coil Units employing:

**2.2.3.1** Volatile Refrigerant Coils.
**2.2.3.2** Only Steam Coils.

**2.2.4** This standard does not apply to Fan-powered Chilled Water Terminals.

## Section 3. Definitions

All terms in this document will follow the standard industry definitions in the *ASHRAE Terminology* website (https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology) and ANSI/ASHRAE Standard 79 unless otherwise defined in this Section.

**3.1** *Air Temperature, Coil Entering (*$EAT_C$*).* The temperature of the air immediately prior to entering the Coil.

**3.2** *Air Temperature, Coil Leaving (*$LAT_C$*).* The temperature of the air as it exits the Fan-coil Unit.

**3.3** *Air Temperature, Unit Entering (*$EAT_U$*).* The temperature of the air immediately prior to entering the Fan-coil Unit.
**3.4** *Air Temperature, Unit Leaving (*$LAT_U$*).* The temperature of the air immediately as it exits the Fan-coil Unit.

**3.5** *Airflow, Actual Entering (*$ACFM_E$*).* The volumetric flowrate of air entering Fan-coil Unit.

**3.6** *Airflow, Actual Leaving (*$ACFM_L$*).* The volumetric flowrate of air leaving the Fan-coil Unit.

**3.7** *Airflow, Standard (SCFM).* The volumetric flowrate of air moving through the Coil after being corrected from $ACFM_E$ or $ACFM_L$.

**3.8** *Appurtenances.* Components in the Fan-coil Unit, other than Coils, located in the air path that have an effect on static pressure drop or create system effect. These include, but are not limited to, filters, Grilles, and diffusers.

**3.9** *Base Unit.* A given configuration of a unit model, size, motor type and Fan type with the least resistance to airflow created by Coils and Appurtenances.

**3.10** *Blow-through*. A unit configuration where the fan(s) is (are) located in the airstream before the Coil such that Fan Heat must be added to the Unit Entering Air Temperature to determine the Coil Entering Air Temperature.

**3.11** *Capacity*.

**3.11.1** *Capacity, Unit Total ($Q_{UT}$)*. The capacity associated with the change in air enthalpy across the Fan-coil Unit which includes both the latent and sensible Capacities expressed in Btu/h.

**3.11.1.1** *Capacity, Unit Latent ($Q_{UL}$)*. The capacity associated with a change in humidity ratio across the Fan-coil Unit expressed in Btu/h.

**3.11.1.2** *Capacity, Unit Sensible ($Q_{US}$)*. The capacity associated with a change in dry-bulb temperature across the Fan-coil Unit expressed in Btu/h.

**3.11.2** *Capacity, Coil Total ($Q_{CT}$)*. The capacity associated with the change in air enthalpy across the Coil only, calculated using the method in AHRI Standard 410, which includes both the Latent and Sensible Capacities expressed in Btu/h.

**3.11.2.1** *Capacity, Coil Latent ($Q_{CL}$)* . The capacity associated with a change in humidity ratio across the Coil only expressed in Btu/h.

**3.11.2.2** *Capacity, Coil Sensible ($Q_{CS}$)*. The capacity associated with a change in dry-bulb temperature across the Fan-Coil Unit expressed in Btu/h.

**3.12** *Coil.* A heat exchanger, with or without extended surfaces, through which a single-phase fluid flows for the purpose of heat transfer in the Fan-coil Unit. A Coil may be a Cooling Coil, Heating Coil or serve both functions.

**3.12.1** *Cooling Coil.* A Coil that is used for reducing the temperature and/or the humidity of the circulating air.
**3.12.2** *Heating Coil*. A Coil that is used for increasing temperature of the circulating air.

**3.13** *Draw-through*. A unit configuration where the fan(s) is located in the airstream after the Coil such that Fan Heat shall be added to the Coil Leaving Air Temperature to determine the Unit Leaving Air Temperature.

**3.14** *Ducted Unit.* A Fan-coil Unit that has provisions for an air passage (duct) to supply Airflow to or from a space. The duct could be on the supply, return, or both.

**3.15** *Fan*. A device for moving air which utilizes a motor-driven impeller.

**3.16** *Fan-coil Unit.* A factory-made assembly that provides Forced-air Circulation, cooling or cooling and heating, and filtering of air, with a maximum design External Static Pressure (ESP) less than or equal to 1.0 in $H_2O$, that does not include the source of cooling or heating, with the exception of optional electric heat.

**3.17** *Fan-powered Chilled Water Terminal (FPCWT).* Devices which include a hydronic Cooling Coil and an airflow regulating primary air valve and in which the primary air valve is in series with the Fan and all air flows through the Fan. The primary air shall bypass the Cooling Coil. The Cooling Coil shall be designed and rated for sensible operation only. The unit may have supplemental heat. The unit shall be designed to be ceiling or floor-plenum mounted and designed for ducted primary air and discharge air.

**3.18** *Fan-coil Unit Motors***.**

**3.18.1** *EC Motor (ECM)*. An electronically commutated permanent magnet motor.
**3.18.2** *PSC Motor*. Single phase AC motor with offset start winding with capacitor.
**3.18.3** *Shaded Pole Motor*. Single phase AC motor with offset start winding and no capacitor.

**3.19** *Fan Heat ($P_e$).* The enthalpy added to the airstream by the Fan and motor. For this standard, the entire electrical power input to the motor is considered to be the Fan Heat.

**3.20** *Fan Setting.* The selected control point for the Fan.

**3.21** *Forced-air Circulation*. Air circulation caused by a difference in pressure produced by a Fan.

**3.22** *Free Delivery Units.* Fan-coil Units intended to be installed in the conditioned space and have no duct attached to distribute conditioned air. The units operate at an External Static Pressure of 0 in $H_2O$ and may be furnished with both integral filters and Grilles on the unit. Free Delivery Units is equal to Non-ducted.

**3.23** *Grille*. Lattice or grating covering the delivery or intake opening of an air passage.

**3.24** *Published Rating*. A statement of the assigned values of those performance characteristics, under stated Rating Conditions, by which a unit may be chosen to fit its application. These values apply to all units of like nominal size and type (identification) produced by the same manufacturer. The term Published Rating includes the rating of all performance characteristics shown on the unit or published in specifications, advertising or other literature controlled by the manufacturer, at stated Rating Conditions.

**3.24.1** *Application Rating*. A rating based on tests performed at conditions outside the range of Standard Rating Conditions.

**3.24.2** *Standard Rating*. Ratings within the range of Standard Rating Conditions and which are accurate representations of test data.

**3.25** *Rating Conditions.* Any set of operating conditions under which a single level of performance results and which causes only that level of performance to occur.

**3.25.1** *Standard Rating Conditions*. Rating Conditions used as the basis of comparison for performance characteristics.

**3.26** *"Shall" or "Should,"* "Shall" or "Should" shall be interpreted as follows:

**3.26.1** *Shall*. Where "shall" or "shall not" is used for a provision specified, that provision is mandatory if compliance with the standard is claimed.

**3.26.2** *Should*. "Should" is used to indicate provisions which are not mandatory but which are desirable as good practice.

**3.27** *Standard Air*. Air weighing 0.075 lb/ft$^3$ which approximates dry air at 70 °F and at a barometric pressure of 29.92 in Hg.

**3.28** *Static Pressure, Additional ($SP_{ADD}$).* The static pressure increase required to move air through the Fan-coil Unit at a given Airflow when the unit is configured with Coil(s) and/or Appurtenances that create a larger pressure drop than the Base Unit.

**3.29** *Static Pressure, External (ESP).* The static pressure required to overcome duct resistance. This value is supplied by the user. For Free Delivery Units, this value is zero.

**3.30** *Steam Coil*. A Heating Coil using steam as the tubeside fluid.

**3.31** *Volatile Refrigerant Coil*. A Coil in which the cooling fluid evaporates during its passage through the Coil.

## Section 4. Test Requirements

**4.1** *Test Requirements*. All published ratings shall be verified by tests conducted in accordance with the provisions set forth in ANSI/ASHRAE Standard 79, except as modified below.

**4.1.1** *Outside Air Dampers*. All testing described in this section shall be conducted with all outside air dampers closed.

**4.1.2** *Electrical Conditions*. Standard rating tests shall be performed at the nameplate rated voltage(s) and frequency. For units with dual nameplate voltage ratings, standard rating tests shall be performed at both voltages, or at the lower of the two voltages if only a single rating is to be Published.

**4.2** *Hydronic and Steam Coils.* For each fin type, the appropriate Coils shall be tested per the requirements of AHRI Standard 410 to allow rating of the coil thermal performance over the range of airflows, entering air temperatures, fluid types, fluid flows, and fluid entering temperatures that are offered by the manufacturer.

**4.3** *Airflow and Power Consumption.* Each Base Unit shall be tested over the range of ESP described below. Airflow testing shall be per ANSI/ASHRAE Standard 79. The Fan-coil Unit(s) Airflow shall be tested without water flow. If different motor types are available, then each motor type shall be tested. If different voltages are offered, then each voltage shall also be tested, unless it can be shown that the airflow and power consumption does not differ by more than 3% between the voltages. At least four (4) points will be measured for each Fan Setting. The manufacturer shall collect enough data to predict the airflow and power consumption for anyFan Settings and any configuration of the unit,.

**4.3.1** *PSC or Shaded Pole Motors with Discrete Taps.* Each unit shall be tested at each discrete tap from 0.0 in $H_2O$ ESP up to the highest ESP plus $SP_{ADD}$ at which the Fan-coil Unit will be rated.

**4.3.2** *EC Motors speed (RPM) or Torque Controlled.* Each unit shall be tested at its maximum, minimum and an intermediate speed or torque. The difference between the intermediate speed tested and the mean of the maximum and minimum speeds shall be less than 15%. Each speed shall be tested from 0.0 in $H_2O$ ESP up to the highest ESP plus $SP_{ADD}$ at which the user will be allowed to rate the Fan-coil Unit.

**4.3.3** *EC Motors Airflow Controlled.* Each unit shall be tested at its maximum, minimum and an intermediate airflow. The difference between the intermediate airflow tested and the mean of the maximum and minimum speeds shall be less than 15%. Each airflow shall be tested from 0.0 in $H_2O$ ESP up to the highest ESP plus $SP_{ADD}$ at which the user will be allowed to rate the Fan-coil Unit.

**4.4** *Capacity.* Fan-coil Units shall be tested for Capacity per the method defined in ANSI/ASHRAE Standard 79 to determine their measured Capacity compared to predicted Capacity calculated from the coil program with fan heat correction. At a minimum at least one unit of each size from given Fan-coil Unit line will be tested. The Base Unit shall be tested at each condition of Table 1:

**Table 1. Test Conditions for Mapping Fan-coil Units Cooling Performance**

| Fan Settings | Entering Dry-bulb Temperature, °F | Entering Wet-bulb Temperature, °F | Entering Water Temperature, °F | Leaving Water Temperature[1], °F |
|---|---|---|---|---|
| High | 80 | 67 | 45 | 55 or 60 |
| High | 75 | 63 | 45 | 55 or 60 |
| High | 72 | 58 | 48 | 58 or 63 |
| Medium[2] | 80 | 67 | 45 | 55 or 60 |
| Medium[2] | 75 | 63 | 45 | 55 or 60 |
| Medium[2] | 72 | 58 | 48 | 58 or 63 |

Notes:
1. Approximate leaving water temperature. Manufacturer shall use 10 or 15 °F delta T.
2. Medium is defined in Section 4.3

**4.4.1** The actual tested Capacity of the Fan-coil Unit shall be within 5% or less than the predicted capacity (from Section 5) for any of the output performance points. If any predicted capacity falls outside of this tolerance, in order to comply with the standard, additional Coil(s) with a higher air pressure drop for the same model size Fan-coil Unit shall be tested at the same conditions to provide additional data needed to make corrections to the Fan-coil Unit performance prediction. (See Appendix C for a discussion of methods for correcting performance prediction.) A sufficient number of tests shall be conducted to ensure that predicted performance is within the tolerance described in Section 5.9.

## Section 5. Rating Requirements

**5.1** *Published Ratings*. Published Ratings of Fan-coil Units shall include the information specified in Section 6.2

**Table 2. Range of Standard Rating Conditions**[1]

| | Cooling | | Heating | |
|---|---|---|---|---|
| Item | Min | Max | Min | Max |
| External Static Pressure, in $H_2O$ | 0 | 1 | 0 | 1 |
| Mean Standard Air Coil Face Velocity, sfpm[2] | 100 | 600 | 100 | 800 |
| Entering Air Dry-bulb Temperature,°F | 65 | 85 | 50 | 75 |
| Relative Humidity, % | 20 | 60 | -- | -- |
| Entering Fluid Temperature., °F | 35 | 65 | 100 | 180 |
| Tube-Side Fluid Velocity, fps | 0.5 | 8 | 0.5 | 8 |
| Fluid Delta Temperature, °F | 5 | 18 | 8 | 40 |
| Fluid Turbulance at Mean Temperature, Re | 700 | -- | 700 | -- |
| Glycol Concentration by Mass, % | 0 | 40 | 0 | 40 |
| Steam Pressure at Coil Inlet, psig | -- | -- | 2 | 15 |
| Maximum Superheat in Steam at Coil Inlet, °F | -- | -- | 0 | 20 |

Notes:
1. Each applicable requirement must be met for the rated performance to be within the scope of the standard.
2. Standard Feet per Minute, sfpm

**5.2** *Standard Ratings*. Standard Ratings shall be established for all conditions within Table 2.

**5.2.1** *Values of Standard Ratings.*

**5.2.1.1** Capacity shall be expressed in terms of Btu/h (in multiples of 100 Btu/h).
**5.2.1.2** Airflow rate shall be expressed in terms of cfm (in multiples of 10 cfm).
**5.2.1.3** Power input shall be expressed in W (in multiples of 1 W).
**5.2.1.4** Water pressure drop shall be expressed in ft $H_2O$ (in multiples of 0.1 ft $H_2O$).

**5.3** *Calculations for Ratings*.

**5.3.1** *Required Inputs*. The following are the inputs that shall be provided by the user or manufacturer in order to rate the performance of a Fan-coil Unit.

**5.3.1.1** *User Inputs.*

**5.3.1.1.1** Fan Setting, Standard Airflow or Actual Entering Airflow, cfm.
**5.3.1.1.2** Altitude, ft or barometric pressure, psia. This is not required if the user entered Standard Airflow from Section 5.3.1.1.1.
**5.3.1.1.3** Power voltage, frequency and phase if offered as options by the manufacturer.
**5.3.1.1.4** External Static Pressure, in $H_2O$, unless the unit is Free-delivery.

**5.3.1.1.5** Entering Water Temperature, °F.
**5.3.1.1.6** Water flow through the Fan-coil Unit, gpm or desired leaving water temperature, °F.
**5.3.1.1.7** Unit Entering Air Temperature, °F.
**5.3.1.1.8** Steam pressure, psig.

**5.3.1.2** *User or Manufacturer Inputs*. These values may be supplied by either the user or the manufacturer.

**5.3.1.2.1** Information about the Coil required by AHRI Standard 410 to calculate the Coil performance.
**5.3.1.2.2** Appurtenances that will affect the Additional Static Pressure.

**5.4** *General Procedure for Rating Fan-coil Units*. The steps shown below, when followed in order, shall be used to calculate the performance of the Fan-coil Unit.

**5.4.1** Calculate the Standard Airflow based on the Fan Setting, the selected Coil and Appurtenances. This is not required if Standard Airflow was entered by the user. See Section 5.6 for the procedure to calculate Standard Airflow.

**5.4.2** Calculate the Coil Entering Air Temperature. If the Fan-coil Unit is Blow-through, the Fan Heat will increase the Unit Entering Air Temperature as shown in Sections 5.7.1 and 5.7.2. If the Fan-coil Unit is Draw-through, the Coil Entering Air Temperature is equal to the Unit Entering Air Temperature.

**5.4.3** Calculate the coil performance per AHRI Standard 410. Apply corrections, if necessary for uneven airflow as determined by testing from Section 4 of this standard. This will provide the values for $Q_{CT}$, $Q_{CL}$ and $Q_{CS}$ when calculating unit capacity in section 5.8 of this standard.

**5.4.4** Calculate the Unit Leaving Air Temperature. If the unit is Blow-through, the Fan-coil Unit Leaving Air Temperature is equal to the Coil Leaving Air Temperature. If the Fan-coil Unit is Draw-through, the Fan Heat will increase the Unit Leaving Air Temperature as shown in Sections 5.7.3 and 5.7.4.

**5.4.5** Calculate the Actual Leaving Airflow as shown in Section 5.6.1.2.

**5.4.6** Calculate the total Capacity and sensible Capacity as shown in Section 5.8.

**5.5** *Psychrometric Calculations*. All psychrometric calculations shall be performed using the equations in ASHRAE Fundamentals, Chapter 1 – Psychrometrics.

**5.6** *Airflow Calculations*.

**5.6.1** *Conversion between ACFM and SCFM.*

**5.6.1.1** *Changing from ACFM to SCFM.*

$$\mathrm{SCFM} = \frac{\mathrm{ACFM}}{(\mathrm{v} \cdot \mathrm{K_1})} \qquad 1$$

Where:

ACFM = either Actual Entering Airflow or Actual Leaving Airflow, cfm
$K_1$ = the density of standard air, 0.075 lb/ft$^3$
SCFM = Standard Airflow, cfm
v = specific volume of the air at the specified psychrometric conditions, ft$^3$/lb

**5.6.1.2** *Changing from SCFM to ACFM.*

$$\mathrm{ACFM} = \mathrm{SCFM} \cdot \mathrm{v} \cdot \mathrm{K_1} \qquad 2$$

Where:

ACFM = either Actual Entering Airflow or Actual Leaving Airflow, cfm

$K_1$ = the density of standard air, 0.075 lb/ $ft^3$
SCFM = Standard Airflow, cfm
v = specific volume of the air at the specified psychrometric conditions, $ft^3$/lb

**5.6.2** *Calculation of Standard Airflow or ESP for Constant Torque or Speed Controlled airflow Fan-coil Units*. This method shall be used to determine the SCFM of a Fan-coil Unit when the ESP and Fan Setting are known or the ESP when the SCFM and Fan Setting are known. The calculations are based on data collected per the requirements in Section 4. This section does not apply to Fan-coil Units with constant airflow controls. See informative Appendix C for examplecalculations.

**5.6.2.1** For each item that creates $SP_{ADD}$, create an equation or set of equations that predicts static pressure losses for each SCFM.

**5.6.2.2** Using the set of SCFM and ESP data for the Base Unit, calculate the $SP_{ADD}$ at each SCFM for the Fan Setting.

**5.6.2.3** Subtract the calculated $SP_{ADD}$ for each SCFM from the associated ESP in the Base Unit data set. This creates a new data set that shows the ESP for each SCFM for the Fan-coil Unit that is being rated.

**5.6.2.4** Use the new data set to create an equation or set of equations that predicts the ESP for a known SCFM or predicts the SCFM for a known ESP. The equations must provide a prediction that is within the tolerance prescribed in Section 5.9.

**5.6.3** *Calculation of Power Consumption*. This method is to be used to determine the power consumption of a Fan-coil Unit when Standard Airflow and ESP are known. See Appendix C for examples of the calculations.

**5.6.3.1** For each item that creates $SP_{ADD}$ , create an equation or set of equations that predicts static pressure losses for each SCFM.

**5.6.3.2** Using the set of SCFM and ESP data for the Base Unit, calculate the $SP_{ADD}$ at each SCFM for the Fan Setting or the SCFM selected for a constant airflow controlled unit.

**5.6.3.3** Subtract the calculated $SP_{ADD}$ for each SCFM from the associated ESP in the Base Unit data set. This creates a new data set that shows the ESP for each SCFM for the Fan-coil Unit that is being rated.

**5.6.3.4** Use the new data set to create an equation or set of equations that predicts the power consumption for a known SCFM and ESP. The equations shall provide a prediction that is within the tolerance prescribed in Section 5.9.

**5.7** *Calculating Coil Entering Air Temperature or Unit Leaving Air Temperature with Fan Heat*. All calculations shown below are with Standard Airflow.

**5.7.1** *Calculate Coil Entering Air Temperature for Blow-through.*

**5.7.1.1** *Dry-bulb Temperature.*

$$\mathrm{EAT_{C_{db}}} = \mathrm{EAT_{U_{db}}} + \left(\frac{\mathrm{K_2 \cdot P_e}}{\mathrm{SCFM}}\right) \quad (3)$$

Where

$EAT_{Cdb}$ = Coil Entering Air Temperature, Dry-bulb, °F
$EAT_{Udb}$ = Unit Entering Air Temperature, Dry-bulb, °F
$K_2$ = 3.146, which is

$$\frac{3.412\ \frac{\mathrm{Btu/h}}{\mathrm{W}}}{\left(60\,\frac{\mathrm{min}}{\mathrm{h}} \cdot 0.075\,\frac{\mathrm{lb}}{\mathrm{ft^3}} \cdot 0.241\ \frac{\mathrm{Btu}}{\mathrm{lb°F}}\right)}$$

$P_e$ = Fan Heat, W

SCFM = Standard Airflow, scfm

**5.7.1.2** *Wet-bulb Temperature*. This value is not required for Heating. Calculate the Coil Entering Air Temperature, Wet-bulb ($EAT_{C_{wb}}$) using the appropriate equations in ASHRAE Fundamentals, Chapter 1, and using $EAT_{Cdb}$ and Unit Entering Air Temperature, Dew-Point $EAT_{U_{dp}}$) as inputs. The other required inputs for the equations shall be based on user-entered values.

**5.7.2** *Calculate Coil Entering Air Temperature for Draw-through.*

**5.7.2.1** $EAT_{C_{db}} = EAT_{U_{db}}$ 4

**5.7.2.2** $EAT_{C_{wb}} = EAT_{U_{wb}}$ 5

**5.7.3** *Calculate Unit Leaving Air Temperature for Blow-through.*

**5.7.3.1** $LAT_{U_{db}} = LAT_{C_{db}}$ 6

**5.7.3.2** $LAT_{U_{wb}} = LAT_{C_{wb}}$ 7

**5.7.4** *Calculate Unit Leaving Air Temperature for Draw-through.*

**5.7.4.1** *Dry-bulb Temperature.*

$$LAT_{U_{db}} = LAT_{C_{db}} + \left(\frac{K_2 \cdot P_e}{SCFM}\right) \quad 8$$

Where

$K_2$ = 3.146, which is

$$\frac{3.412\ \frac{btu/h}{W}}{\left(60\,\frac{min}{h} \cdot 0.075\,\frac{lb}{ft^3} \cdot 0.241\,\frac{Btu}{lb°F}\right)}$$

$LAT_{U_{db}}$ = Unit Leaving Air Temperature, Dry-bulb, °F
$LAT_{C_{db}}$= Coil Leaving Air Temperature, Dry-bulb, °F
$P_e$ = Fan Heat, W
SCFM = Standard Airflow, scfm

**5.7.4.2** *Wet-bulb Temperature.* This value is not required for Heating. Calculate the Coil Leaving Air Temperature, Wet-bulb ($LAT_{C_{wb}}$) using the appropriate equations in ASHRAE Fundamentals, Chapter 1, and using $LAT_{Cdb}$ and Unit Leaving Air Temperature, Dew-Point ($LAT_{U_{dp}}$) as inputs. The other required inputs for the equations shall be based on user-entered values.

**5.8** *Calculation of Capacity.* Calculation of Unit Total Capacity, Unit Latent Capacity, and Unit Sensible Capacity

**5.8.1** *Calculation When the Air is Heated.* Latent Capacity does not apply.

**5.8.1.1** *Unit Total Capacity*.

$$Q_{UT} = Q_{CT} + P_e \cdot K_3 \quad 9$$

Where

$K_3$ = 3.412 (Btu/h)/W
$P_e$ = Fan Heat, W
$Q_{CT}$ = Coil Total Capacity, Btu/h
$Q_{UT}$ = Unit Total Capacity, Btu/h

**5.8.1.2** *Unit Sensible Capacity.*

$$Q_{US} = Q_{UT} \quad (10)$$

Where

$Q_{US}$ = Unit Sensible Capacity, Btu/h
$Q_{UT}$ = Unit Total Capacity, Btu/h

**5.8.2** *Calcuation When the Air is Cooled.*

**5.8.2.1** *Unit Total Capacity.*

$$Q_{UT} = Q_{CT} - P_e \cdot K_3 \quad (11)$$

Where

$K_3$ = 3. 412 (Btu/h)/W
$P_e$ = Fan Heat, W
$Q_{CT}$ = Coil Total Capacity, Btu/h calculated per AHRI Standard 410
$Q_{UT}$ = Unit Total Capacity, Btu/h

**5.8.2.2** *Unit Latent Capacity.*

$$Q_{UL} = Q_{CL} \quad (12)$$

Where

$Q_{CL}$ = Coil Latent Capacity, Btu/h
$Q_{UL}$ = Unit Latent Capacity, Btu/h

**5.8.2.3** *Unit Sensible Capacity.*

$$Q_{US} = Q_{UT} - Q_{UL} \quad (13)$$

Where

$Q_{UL}$ = Unit Latent Capacity, Btu/h
$Q_{US}$ = Unit Sensible Capacity, Btu/h
$Q_{UT}$ = Unit Total Capacity, Btu/h

**5.9** *Tolerances*. The Standard Rating shall be such that any Fan-coil Unit selected at random and tested in accordance with this standard has an Airflow Rate, total cooling Capacity, heating Capacity and sensible cooling Capacity not less than 95% of the Standard Ratings, an electrical power input not more than 110% or 15 Watts if the Rating is 150 Watts or below. of the Standard Ratings, and a Water Pressure Drop not more than 110% of the Standard Rating or Standard Rating + 1 ft $H_2O$, whichever is greater.

## Section 6. Minimum Data Requirements for Published Ratings

**6.1** *Minimum Data Requirements for Published Ratings*. Published Ratings shall include all ratings provided by the manufacturer for a model of Fan-coil Unit whether or not the rating is within the scope of the Standard. All claims to ratings within the scope of this standard shall include the statement “Rated in accordance with AHRI Standard 440 (I-P)”. All claims to ratings outside the scope of this standard shall include the statement “Outside the scope of AHRI Standard 440 (I-P)”.

**6.2** *Content of Published Ratings*. Published Ratings at a selected performance point shall consist of the following information:

**6.2.1** Manufacturer's name.
**6.2.2** Rating Source. At least one of the following shall be provided.

**6.2.2.1** Software version number and release date
**6.2.2.2** Catalog publication number and date

**6.2.3** Model, size and/or type.

**6.2.4** Airside Information.

**6.2.4.1** Standard Airflow rate, scfm, at dry-coil conditions and/or entering and leaving airflow rates at actual conditions, acfm.
**6.2.4.2** Barometric pressure, psia and/or equivalent elevation, ft.
**6.2.4.3** Capacity.

**6.2.4.3.1** Total cooling, Btu/h (cooling operation only).
**6.2.4.3.2** Sensible, Btu/h (heating and cooling operation).

**6.2.4.4** Entering Air Temperatures.

**6.2.4.4.1** Dry-bulb ($EAT_{Udb}$), °F.
**6.2.4.4.2** Wet-bulb ($EAT_{Uwb}$), °F (cooling operation only).

**6.2.4.5** External Static Pressure, in $H_2O$.

**6.2.5** Fluid Information.

**6.2.5.1** Fluid Type [water, aqueous glycol solution or steam].

**6.2.5.1.1** Water.

**6.2.5.1.1.1** Entering water temperature, °F.
**6.2.5.1.1.2** Leaving water temperature, °F.
**6.2.5.1.1.3** Flow at actual rate, gpm.
**6.2.5.1.1.4** Water head loss through the Fan-coil Unit at the mean liquid density, ft $H_2O$, reported with up to 1 decimal place.

**6.2.5.1.2** Aqueous Glycol.

**6.2.5.1.2.1** Glycol Type (aqueous glycol solution only).
**6.2.5.1.2.2** Glycol Concentration by mass ,% (aqueous glycol solution only).
**6.2.5.1.2.3** Entering fluid temperature, °F.
**6.2.5.1.2.4** Leaving fluid temperature, °F.
**6.2.5.1.2.5** Flow at actual rate, gpm.
**6.2.5.1.2.6** Liquid head loss through the Fan-coil Unit at the mean liquid density, ft $H_2O$, reported with up to 1 decimal place.

**6.2.5.1.3** Steam.

**6.2.5.1.3.1** Rated entering steam pressure, psig.
**6.2.5.1.3.2** Maximum safe steam entering pressure, psig.

**6.2.6** Electrical and Motor Information.

**6.2.6.1** Motor Type.
**6.2.6.2** Voltage, V/Phase/Frequency, Hz.
**6.2.6.3** Motor full load current (FLA), amps.
**6.2.6.4** Nominal Motor Speed, rpm.

**6.2.6.4.1** Rated setting, if motor has discrete steps (e.g. high, medium, low).
**6.2.6.4.2** Actual motor speed if motor does not have discrete steps, rpm.
**6.2.6.4.3** For constant airflow controlled units, show "constant airflow controlled".

**6.2.6.5** Electric power input at the rated condition, W.

**6.2.7** Filters Information.

**6.2.7.1** Type.
**6.2.7.2** Thickness, in.

## Section 7. Operating Requirements

**7.1** *Operating Requirements.* To comply with this standard, any production unit shall meet the requirements detailed here.

**7.2** *Insulation Efficiency Test*. Fan-Coil Units shall pass the following insulation efficiency test. The test set up shall be the same as for performance tests per ANSI/ASHRAE Standard 79.

**7.2.1** *Test Conditions*.

**7.2.1.1** Ambient air temperature: 80 °F dry-bulb, 75 °F wet-bulb.
**7.2.1.2** Entering water temperature: 42 °F.
**7.2.1.3** Leaving water temperature: 52 °F.

**7.2.1.3.1** Exception: If the resulting water pressure drop is greater than 20 ft $H_2O$ the leaving water temperature shall be increased such that the Water Pressure Drop is equal to 20 ft $H_2O$.

**7.2.1.4** Airflow shall not be less than 60% and not more that 80% of the maximum airflow of which the Fan-coil Unit is capable.

**7.2.2** *Procedure*. After establishing specified temperature conditions, the unit shall operate continuously at its lowest fan speed for a period of two hours at the following External Static Pressure:

**7.2.2.1** Free Delivery Units 0.0 in $H_2O$.
**7.2.2.2** Ducted Unit at least 0.05 in $H_2O$ and to be sufficient to limit airflow to the requirements listed in Section 7.2.1.4.

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

**7.3** *Low Voltage Test*. Fan-Coil Units shall start and operate at 90% of nameplate rated voltage at all fan speed settings.

## Section 8. Marking and Nameplate Data

**8.1** *Nameplate Data.* As a minimum, the nameplate on Fan-coil Units shall display the manufacturer's name, model designation, and electrical characteristics.

**8.2** *Nameplate Voltages.* Nameplate voltages for 60 Hz systems shall include one or more of the utilization voltages shown in Table 1 of AHRI Standard 110. Nameplate voltages for 50 Hz systems shall include one or more of the utilization voltages shown in Table 1 of IEC Standard 60038.

## Section 9. Conformance Conditions

**9.1** *Conformance*. While conformance with this standard is voluntary, conformance shall not be claimed or implied for products or equipment within the standard's *Purpose* (Section 1) and *Scope* (Section 2) unless such product claims meet all of the requirements of the standard and all of the testing and rating requirements are measured and reported in complete compliance with the standard. Any product that has not met all the requirements of the standard shall not reference, state, or acknowledge the standard in any written, oral, or electronic communication.

# APPENDIX A. REFERENCES - NORMATIVE

**A1** Listed here are all standards, handbooks and other publications essential to the formation and implementation of the standard. All references in this appendix are considered as part of the standard.


**A1.1** AHRI Standard 110-2016, *Air-conditioning, Heating and Refrigerating Equipment Nameplate Voltages*, 2016, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

**A1.2** AHRI Standard 410 – 2001, *Forced-Circulation Air-Cooling and Air-Heating Coils,* 2001**,** American National Standards Institute/Air-Conditioning, Heating, and Refrigeration Institute, 11 West 42nd Street, New York, NY 10036, U.S.A./ 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

**A1.3** AHRI Standard 430 (I-P)-2014, *Performance Rating of Central Station Air-handling Unit Supply Fans*, 2014, Air-Conditioning, Heating, and Refrigeration Institute, 11 West 42nd Street, New York, NY 10036, U.S.A./ 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

**A1.4** AHRI Standard 840 (I-P)-2015, *Performance Rating of Unit Ventilators*, 2015, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

**A1.5** ANSI/ASHRAE Standard 79-2015, *Method of Test for Fan-Coil Units*, 2015, American Society of Heating Refrigeration and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

**A1.6** ASHRAE *Handbook, HVAC Applications*, 2015, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, Inc., 1791 Tullie Circle, N.E., Atlanta, GA, 30329, U.S.A.

**A1.7** ASHRAE Terminology, https://www.ashrae.org/resources--publications/free-resources/ashrae-terminology, 2017, American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc., 1791 Tullie Circle N.E., Atlanta, GA 30329, U.S.A.

**A1.8** IEC Standard 60038-2009, *IEC Standard Voltages, 2009,* International Electrotechnical Commission, 3, rue de Varembe, P.O. Box 131, 1211 Geneva 20, Switzerland.


# APPENDIX B. REFERENCES - INFORMATIVE

**B1** Listed here are standards, handbooks and other publications which may provide useful information and background but are not considered essential. References in this appendix are not considered as part of the standard.


**B1.1** AHRI Standard 260-2017 *Sound Rating of Ducted Air Moving and Conditioning Equipment*, 2017, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

**B1.2** ANSI/AHRI Standard 350-2015 *Sound Rating of Non-ducted Indoor Air-conditioning Equipment*, 2015, Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd, Suite 500, Arlington, VA 22201, U.S.A.

# APPENDIX C. CALCULATING AIRFLOW AND POWER INPUT BASED ON TEST DATA COLLECTED ON THE BASE UNIT - INFORMATIVE

**C1** This appendix contain an example to illustrate how airflow and power can be calculated by interpolation for any user-entered input for required airflow or ESP.

**C1.1** *Calculating Airflow and Power Input Based on Test Data Collected on the Base Unit*. Table C1 contains example airflow test data collected per ANSI/ASHRAE Standard 79 on a Base Unit. This Base Unit was tested with a 3-row, 10 fins-per-inch coil and a MERV-4 rated filter. The motor is a ECM motor that is controlled by constant torque output. The data was collected for each motor setting (100%, 50%, and 30%) at various ESP's, ranging from 0.0 to 1.0 in $H_2O$. Example plots are shown in Figure C1 and Figure C2.

**Table C1. Example Airflow Test Data**

| Torque, % | Airflow, scfm | ESP, in $H_2O$ | $SP_{ADD}$, in $H_2O$ | Sum of ESP and $SP_{ADD}$, in $H_2O$ | Power, W |
|---|---|---|---|---|---|
| 100 | 926.4 | 0.0 | 0.0 | 0.0 | 286 |
| 100 | 894.9 | 0.1 | 0.0 | 0.1 | 273 |
| 100 | 851.1 | 0.2 | 0.0 | 0.2 | 261 |
| 100 | 800.2 | 0.3 | 0.0 | 0.3 | 247 |
| 100 | 743.2 | 0.4 | 0.0 | 0.4 | 231 |
| 100 | 689.9 | 0.5 | 0.0 | 0.5 | 212 |
| 100 | 632.2 | 0.6 | 0.0 | 0.6 | 195 |
| 100 | 551.6 | 0.7 | 0.0 | 0.7 | 179 |
| 100 | 448.8 | 0.8 | 0.0 | 0.8 | 153 |
| 100 | 275.5 | 0.9 | 0.0 | 0.9 | 106 |
| 100 | 194.8 | 1.0 | 0.0 | 1.0 | 88 |
| 50 | 722.4 | 0.0 | 0.0 | 0.0 | 139 |
| 50 | 698.2 | 0.1 | 0.0 | 0.1 | 146 |
| 50 | 670.0 | 0.2 | 0.0 | 0.2 | 150 |
| 50 | 647.1 | 0.3 | 0.0 | 0.3 | 156 |
| 50 | 616.9 | 0.4 | 0.0 | 0.4 | 158 |
| 50 | 591.7 | 0.5 | 0.0 | 0.5 | 165 |
| 50 | 561.9 | 0.6 | 0.0 | 0.6 | 166 |
| 50 | 504.7 | 0.7 | 0.0 | 0.7 | 159 |
| 50 | 389.8 | 0.8 | 0.0 | 0.8 | 137 |
| 50 | 238.6 | 0.9 | 0.0 | 0.9 | 105 |
| 50 | 194.8 | 1.0 | 0.0 | 1.0 | 87 |
| 30 | 534.1 | 0.0 | 0.0 | 0.0 | 68 |
| 30 | 505.0 | 0.1 | 0.0 | 0.1 | 71 |
| 30 | 470.0 | 0.2 | 0.0 | 0.2 | 75 |
| 30 | 444.6 | 0.3 | 0.0 | 0.3 | 80 |
| 30 | 413.5 | 0.4 | 0.0 | 0.4 | 83 |
| 30 | 379.9 | 0.5 | 0.0 | 0.5 | 90 |
| 30 | 337.5 | 0.6 | 0.0 | 0.6 | 92 |
| 30 | 283.0 | 0.7 | 0.0 | 0.7 | 94 |
| 30 | 238.6 | 0.8 | 0.0 | 0.8 | 99 |
| 30 | 194.8 | 0.9 | 0.0 | 0.9 | 97 |

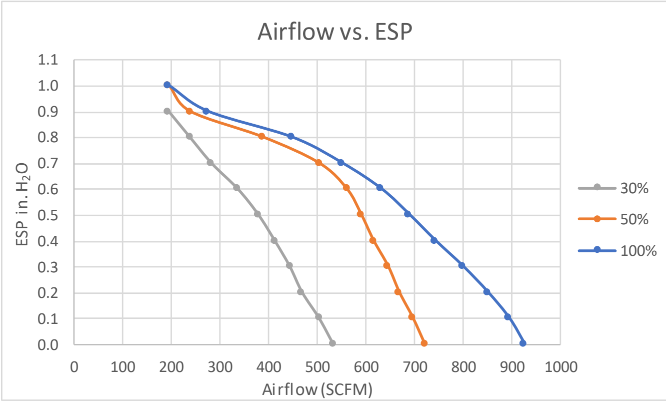


**Figure C1. Example Test Data Airflow versus ESP**

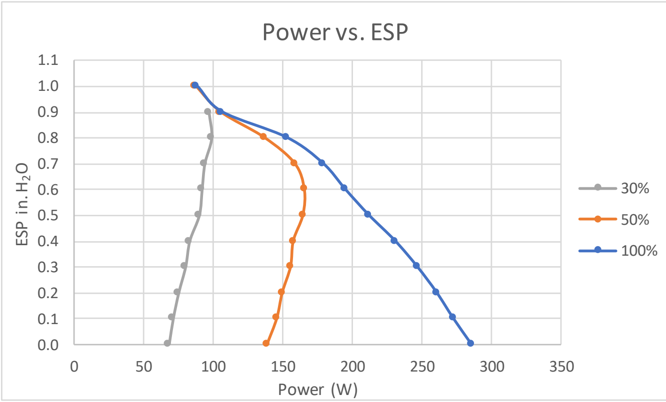


**Figure C2. Example Test Data Power versus ESP**

Notes:

1. The collection of data shown in this example are more data points collected for each motor setting than the minimum of four required in Section 4.3. The standard number of data points for airflow requirements in the body of the standard are minimums. The User of the standard can determine the amount of data collected to provide ratings that meet the their own requirements but be no less than the minimum accuracy requirements of Section 6.

2. The power consumption data does not follow fan laws as illustrated in Figure C2. The shaft input power of the fan follows fan laws, in some case due to the programming of motors, particularly when combined with a speed controller, the power often does not.

3. Table C1 shown above includes columns for $SP_{ADD}$ and the sum of ESP and $SP_{ADD}$. ANSI/ASHRAE Standard 79 does not require such data but it is included here for clarity.

**C1.1.1** *Example 1. Rating the Base Unit at a Different ESP.* The user wants to know the airflow with an ESP different than one of the tested points.

Fan setting: 50% torque
Required ESP: 0.27 in $H_2O$
A linear interpolation can be used in the example below. This approximation provides appropriate accuracy. The user can use another method as needed.
Airflow at 0.2 in $H_2O$: 670.0 scfm
Airflow at 0.3 in $H_2O$: 641.1 scfm

Calculation for airflow at 0.27 in $H_2O$:

$$\left(\frac{0.27-0.2}{0.3-0.2}\right)\cdot(641.1-670.0)+670.0=649.8\text{ scfm}$$

**C1.1.2** *Example 2. Rating the Base Unit at a Different Airflow.* The user wants to know the ESP with an airflow different than one of the tested points.

Fan setting: 100% torque
Required Airflow: 875 scfm
A linear interpolation can be used in the example below. This approximation provides appropriate accuracy. The user can use another method as needed.
ESP at 894.9 scfm: 0.1 in $H_2O$
ESP at 851.1 scfm: 0.2 in $H_2O$

Calculation for ESP at 875 scfm Airflow:

$$\left(\frac{875.0-851.1}{894.9-851.1}\right)\cdot(0.1-0.2)+0.2=0.145\text{ in }H_2O$$

**C1.2** *Calculating Results with an $SP_{ADD}$ Different than Zero*. In this case, create the data table for this unit with a MERV-8 filter in place of the MERV-4 filter and a 4-row 12 fins-per-inch coil in place of a Coil of Base Unit Coil. Air Pressure Drop (APD) curves based on either filter manufacturer or directly-tested data. It is based on the air velocity in ft/s (FPS) through the coil:

Coil Face Area: 3.0 $ft^2$
MERV-4 filter: $\text{APD} = \text{FPS}^2 \cdot 0.0000004$
MERV-8 filter: $\text{APD} = \text{FPS}^2 \cdot 0.0000010$

$$\text{FPS} = \frac{\text{SCFM}}{3.0}$$

$$\text{SP}_{\text{ADD}} = \left(\frac{\text{SCFM}}{3.0}\right)^2 \cdot (0.000010 - 0.0000004)$$

$$\text{SP}_{\text{ADD}} = \left(\frac{\text{SCFM}}{3.0}\right)^2 \cdot (0.0000006)$$

APD curves for 3-row, 10 FPI coil and 4-row, 12 FPI coil based on AHRI Standard 410 rating program.

Coil Face Area: 2.7 $ft^2$
3-row, 10 FPI: $APD = \left(\frac{\text{SCFM}}{2.7}\right)^2 \cdot 0.0000015$
4-row, 12 FPI: $APD = \left(\frac{\text{SCFM}}{2.7}\right)^2 \cdot 0.0000023$

$$\text{SP}_{\text{ADD}} = \left(\frac{\text{SCFM}}{2.7}\right)^2 \cdot (0.000023 - 0.0000015)$$

$$\text{SP}_{\text{ADD}} = \left(\frac{\text{SCFM}}{2.7}\right)^2 \cdot (0.0000008)$$

**C1.2.1** Create the performance table for this unit based on the Base Unit.

**C1.2.1.1** *Step 1.* Calculate the value of $SP_{ADD}$ for each airflow from the Base Unit Table and subtract that value from the sum of ESP and $SP_{ADD}$ to calculate the new ESP. For example, the value of $SP_{ADD}$ for the first record is as follows:

$$\text{SP}_{\text{ADD}} = \left[\left(\frac{926.4}{3}\right)^2 \cdot 0.0000006\right] + \left[\left(\frac{926.4}{2.7}\right)^2 \cdot 0.0000008\right] = 0.15\text{ in }H_2O$$

Table C2 is the Base Unit table with the $SP_{ADD}$ and new ESP values.

**Table C2. Example Airflow Data plus $SP_{ADD}$**

| Torque, % | Airflow, scfm | ESP, in $H_2O$ | $SP_{ADD}$, in $H_2O$ | Sum of ESP and $SP_{ADD}$, in $H_2O$ | Power, W |
|---|---|---|---|---|---|
| 100 | 926.4 | -0.15 | 0.15 | 0.0 | 286 |
| 100 | 894.9 | -0.04 | 0.14 | 0.1 | 273 |
| 100 | 851.1 | 0.07 | 0.13 | 0.2 | 261 |
| 100 | 800.2 | 0.19 | 0.11 | 0.3 | 247 |
| 100 | 743.2 | 0.30 | 0.10 | 0.4 | 231 |
| 100 | 689.9 | 0.42 | 0.08 | 0.5 | 212 |
| 100 | 632.2 | 0.53 | 0.07 | 0.6 | 195 |
| 100 | 551.6 | 0.65 | 0.05 | 0.7 | 179 |
| 100 | 448.8 | 0.76 | 0.04 | 0.8 | 153 |
| 100 | 275.5 | 0.89 | 0.01 | 0.9 | 106 |
| 100 | 194.8 | 0.99 | 0.01 | 1.0 | 88 |
| 50 | 722.4 | -0.09 | 0.09 | 0.0 | 139 |
| 50 | 698.2 | 0.01 | 0.09 | 0.1 | 146 |
| 50 | 670.0 | 0.12 | 0.08 | 0.2 | 150 |
| 50 | 647.1 | 0.23 | 0.07 | 0.3 | 156 |
| 50 | 616.9 | 0.33 | 0.07 | 0.4 | 158 |
| 50 | 591.7 | 0.44 | 0.06 | 0.5 | 165 |
| 50 | 561.9 | 0.54 | 0.06 | 0.6 | 166 |
| 50 | 504.7 | 0.66 | 0.04 | 0.7 | 159 |
| 50 | 389.8 | 0.77 | 0.03 | 0.8 | 137 |
| 50 | 238.6 | 0.89 | 0.01 | 0.9 | 105 |
| 50 | 194.8 | 0.96 | 0.01 | 1.0 | 87 |
| 30 | 534.1 | -0.05 | 0.05 | 0.0 | 68 |
| 30 | 505.0 | 0.06 | 0.04 | 0.1 | 71 |
| 30 | 470.0 | 0.16 | 0.04 | 0.2 | 75 |
| 30 | 444.6 | 0.27 | 0.03 | 0.3 | 80 |
| 30 | 413.5 | 0.37 | 0.03 | 0.4 | 83 |
| 30 | 379.9 | 0.47 | 0.03 | 0.5 | 90 |
| 30 | 337.5 | 0.58 | 0.02 | 0.6 | 92 |
| 30 | 283.0 | 0.69 | 0.01 | 0.7 | 94 |
| 30 | 238.6 | 0.79 | 0.01 | 0.8 | 99 |
| 30 | 194.8 | 0.89 | 0.01 | 0.9 | 97 |

**C1.2.1.2** *Step 2.* Eliminate value(s) of ESP less than 0.0 in $H_2O$ and calculate a new 0.0 in $H_2O$ ESP record. Negative ESP values (highlighted in yellow) are no longer part of the new data set (i.e. the 4 row example shown), so they are eliminated from the example. Table C3 illustrates the updated data (highlighted in green) for ESP values of 0 in $H_2O$ using interpolation.

| Table C3. Example Airflow Data with Interpolation | | | | | |
|---|---|---|---|---|---|
| Torque, % | Airflow, scfm | ESP, in $H_2O$ | $SP_{ADO}$, in $H_2O$ | Sum of ESP and $SP_{ADO}$, in $H_2O$ | Power, W |
| ~~100~~ | ~~926.4~~ | ~~-0.15~~ | ~~0.15~~ | ~~0.00~~ | ~~286~~ |
| ~~100~~ | ~~894.9~~ | ~~-0.04~~ | ~~0.14~~ | ~~0.20~~ | ~~273~~ |
| 100 | 879.0 | 0.00 | 0.14 | 0.14 | 268.6 |
| 100 | 851.1 | 0.07 | 0.13 | 0.20 | 261 |
| 100 | 800.2 | 0.19 | 0.11 | 0.30 | 247 |
| 100 | 743.2 | 0.30 | 0.10 | 0.40 | 231 |
| 100 | 689.9 | 0.42 | 0.08 | 0.50 | 212 |
| 100 | 632.2 | 0.53 | 0.07 | 0.60 | 195 |
| 100 | 551.6 | 0.65 | 0.05 | 0.70 | 179 |
| 100 | 448.8 | 0.76 | 0.04 | 0.80 | 153 |
| 100 | 275.5 | 0.89 | 0.01 | 0.90 | 106 |
| 100 | 194.8 | 0.99 | 0.01 | 1.00 | 88 |
| ~~50~~ | ~~722.4~~ | ~~-0.09~~ | ~~0.09~~ | ~~0.00~~ | ~~139~~ |
| 50 | 701.4 | 0.00 | 0.09 | 0.09 | 145.1 |
| 50 | 698.2 | 0.01 | 0.09 | 0.1 | 146 |
| 50 | 670.0 | 0.12 | 0.08 | 0.20 | 150 |
| 50 | 647.1 | 0.23 | 0.07 | 0.30 | 156 |
| 50 | 616.9 | 0.33 | 0.07 | 0.40 | 158 |
| 50 | 591.7 | 0.44 | 0.06 | 0.50 | 165 |
| 50 | 561.9 | 0.54 | 0.06 | 0.60 | 166 |
| 50 | 504.7 | 0.66 | 0.04 | 0.70 | 159 |
| 50 | 389.8 | 0.77 | 0.03 | 0.80 | 137 |
| 50 | 238.6 | 0.89 | 0.01 | 0.90 | 105 |
| 50 | 194.8 | 0.96 | 0.01 | 1.00 | 87 |
| ~~30~~ | ~~534.1~~ | ~~-0.05~~ | ~~0.05~~ | ~~0.00~~ | ~~68~~ |
| 30 | 520.2 | 0.00 | 0.05 | 0.05 | 69.4 |
| 30 | 505.0 | 0.06 | 0.04 | 0.1 | 71 |
| 30 | 470.0 | 0.16 | 0.04 | 0.20 | 75 |
| 30 | 444.6 | 0.27 | 0.03 | 0.30 | 80 |
| 30 | 413.5 | 0.37 | 0.03 | 0.40 | 83 |
| 30 | 379.9 | 0.47 | 0.03 | 0.50 | 90 |
| 30 | 337.5 | 0.58 | 0.02 | 0.60 | 92 |
| 30 | 283.0 | 0.69 | 0.01 | 0.70 | 94 |
| 30 | 238.6 | 0.79 | 0.01 | 0.80 | 99 |
| 30 | 194.8 | 0.89 | 0.01 | 0.90 | 97 |

**C1.2.1.3** *Step 3*. The User may elect to clean up table by eliminating calculation fields unnecessary for published data. The final table is shown in Table C4.

**Table C4. Example Final Airflow Data**

| Torque, % | Airflow, scfm | ESP, in $H_2O$ | Power, W |
|---|---|---|---|
| 100 | 879.0 | 0.00 | 268.6 |
| 100 | 851.1 | 0.07 | 261 |
| 100 | 800.2 | 0.19 | 247 |
| 100 | 743.2 | 0.30 | 231 |
| 100 | 689.9 | 0.42 | 212 |
| 100 | 632.2 | 0.53 | 195 |
| 100 | 551.6 | 0.65 | 179 |
| 100 | 448.8 | 0.76 | 153 |
| 100 | 275.5 | 0.89 | 106 |
| 100 | 194.8 | 0.99 | 88 |
| 50 | 701.4 | 0.00 | 145.1 |
| 50 | 698.2 | 0.01 | 146 |
| 50 | 670.0 | 0.12 | 150 |
| 50 | 647.1 | 0.23 | 156 |
| 50 | 616.9 | 0.33 | 158 |
| 50 | 591.7 | 0.44 | 165 |
| 50 | 561.9 | 0.54 | 166 |
| 50 | 504.7 | 0.66 | 159 |
| 50 | 389.8 | 0.77 | 137 |
| 50 | 238.6 | 0.89 | 105 |
| 50 | 194.8 | 0.96 | 87 |
| 30 | 520.2 | 0.00 | 69.4 |
| 30 | 505.0 | 0.06 | 71 |
| 30 | 470.0 | 0.16 | 75 |
| 30 | 444.6 | 0.27 | 80 |
| 30 | 413.5 | 0.37 | 83 |
| 30 | 379.9 | 0.47 | 90 |
| 30 | 337.5 | 0.58 | 92 |
| 30 | 283.0 | 0.69 | 94 |
| 30 | 238.6 | 0.79 | 99 |
| 30 | 194.8 | 0.89 | 97 |

# APPENDIX D. EXAMPLE METHOD OF ADJUSTING CAPACITY FOR NON- UNIFORM AIRFLOW IN A FAN-COIL UNIT USING AHRI STANDARD 410 OUTPUTS – INFORMATIVE

**D1** This appendix illustrates an example how to adjust AHRI Standard 410 prediction outputs to account for non- uniform airflow across a hydronic coil in an OEM's fan coil cabinet. The example illustrates test data collected per ANSI/ASHRAE Standard 79 on a Base Unit.

**D1.1** *Base Unit Specification & Dimensions.* This example unit was tested with a 3-row, 12 fins-per-inch Coil and a MERV-4 filter. The coil specification & dimensions are shown in Table D1.

**Table D1. Coil Specifications and Dimensions**

| | |
|---|---|
| Number of Rows | 3 |
| Number of circuits | 3 |
| Height (H), in | 15 |
| Width (W), in | 19 |
| Fins per inch, FPI | 12 |
| Fin Thickness, in | 0.0045 |
| Fin Material | Aluminum |
| Fin Type | Sine Wave |
| Tube Size, in | 1/2 |
| Tube Wall, in | 0.016 |

**D1.2** *Fan Coil Inputs and AHRI Standard 410 Outputs.* A fan coil with 800 cfm with a 3 row coil and specifications and inputs shown in Table D1 and Table D2, respectively has AHRI Standard 410 outputs shown in Table D3.

**Table D2. Fan Coil Inputs**

| | |
|---|---|
| Entering Dry-bulb Temperature (EDB), °F | 80 |
| Entering Wet-bulb Temperature (EWB), °F | 67 |
| Entering Water Temperature (EWT) , °F | 45 |
| Airflow, cfm | 800 |
| Leaving Water Temperature (LWT), °F | 55 |
| Fluid Type | Water |

**Table D3. AHRI Standard 410 Outputs**

| | |
|---|---|
| Total Capacity (TC), Btu/h | 22,274 |
| Sensible Capacity (SC), Btu/h | 17,036 |
| Standard Airflow, scfm | 785 |
| Air Pressure Drop (APD), in $H_2O$ | 0.276 |
| Leaving Water Temperature (LWT), °F | 55 |
| Leaving Dry-bulb Temperature, (LDB), °F | 60.4 |
| Leaving Water Temperature, (LWB), °F | 58.5 |
| Fluid Flow, gpm | 4.44 |
| Water Pressure Drop (WPD), ft $H_2O$ | 3.83 |

**D1.3** ANSI/*ASHRAE Standard 79 Test Outputs*. The tested data using ANSI/ASHRAE Standard 79 Method of Test is 94% of the AHRI Standard 410 predicted output due to the non-uniform airflow across the coil inside the fan coil cabinet, shown in Table D4. AHRI Standard 410 requires an 80% airflow uniformity in the test setup requirements. In some fan coil cabinets the effective area of the coil can be reduced by non-uniform airflow.

| Table D4. ANSI/ASHRAE Standard 79 Test Outputs | |
|---|---|
| Total Capacity (TC), Btu/h | 20,937 |
| Sensible Capacity (SC), Btu/h | 16,016 |
| Standard Airflow, scfm | 785 |
| Air Pressure Drop (APD), in $H_2O$ | 0.34 |
| Leaving Water Temperature (LWT), °F | 55 |
| Leaving Dry-bulb (LDB), °F | 61 |
| Leaving Wet-bulb (LWB), °F | 59 |
| Fluid Flow, gpm | 4.2 |
| Water Pressure Drop (WPD), ft $H_2O$ | 3.4 |

**D1.4** *Effective Airflow Area Adjustment.* If the effective airflow area adjustment is taken for the coil dimensions, the effective coil dimension is reduced by 1.2 in in width, shown in Table D5.

| Table D5. Adjust Effective Coil Area | |
|---|---|
| Number of Rows | 3 |
| Number of Circuits | 3 |
| Height (H), in | 15 |
| Width (W), in | 17.8 |
| Fins per inch, FPI | 12 |
| Fin Thickness, in | 0.0045 |
| Fin Material | Aluminum |
| Fin Type | Sine Wave |
| Tube Size, in | 1/2 |
| Tube Wall, in | 0.016 |

**D1.5** *Predicted Output.* The adjusted predicted output of the AHRI Standard 410 is shown in Table D6.

| Table D6. Predicted AHRI Standard 410 Outputs | |
|---|---|
| Total Capacity (TC), Btu/h | 21,281 |
| Sensible Capacity (SC), Btu/h | 16,587 |
| Standard Airflow, scfm | 785 |
| Air Pressure Drop (APD), in $H_2O$ | 0.307 |
| Leaving Water Temperature (LWT), °F | 55 |
| Leaving Dry-bulb (LDB), °F | 60.9 |
| Leaving Wet-bulb (LWB), °F | 58.9 |
| Fluid Flow, gpm | 4.23 |
| Water Pressure Drop (WPD), ft $H_2O$ | 3.36 |

**D1.6** *Fan Coil Net Capacity*. The fan motor combination consumes 150 W for the 785 scfm run through the fan coil. Adjusting for the motor heat using previous section calculation method, 511 Btu/h is removed from the gross capacity (total and sensible) to provide the fan coil net capacity.

$$TC_{net} = TC_{gross} - Motor\ Heat \quad \text{D1}$$
$$= 21{,}281 - 511$$
$$= 20{,}770\ \text{Btu/h}$$

$$SC_{net} = 16{,}587 - 511$$
$$= 16{,}076\ \text{Btu/h}$$

**D1.7** *Non-Uniform Airflow*. In making the adjustment to effective area of the coil the AHRI Standard 410 capacity is now equivalent to the actual ANSI/ASHRAE Standard 79 tested laboratory capacity by taking into account non-uniform airflow across the coil.

Predicted TC = 20,770 Btu/h ANSI/ASHARE Standard 79 Output = 20,937 Btu/h
Predicted SC = 16,076 Btu/h ANSI/ASHRAE Standard 79 Output = 16,016 Btu/h

**D1.7.1** *Non-uniformity Correction Factor*. Similarly, additional rows of coil in the same fan coil cabinet can be predicted with the understanding of the non-uniformity correction factor. These values are OEM dependent and these calculations and predictions are for example purposes only.