

# Airflow quick reference guide

## Calculating Air Changes per Hour

$$ACH = Q \times 60 / \text{Room Volume ft}^3$$

$$Q = \text{ft}^3/\text{minute (CFM)}$$

## Calculating Air Velocity (Standard, 70 °F @ 29.92 in. Hg)

$$V = 4005 \times \sqrt{VP}$$

$$VP = (V/4005)^2$$

$$V = \text{Velocity, fpm}$$

$$VP = \text{Velocity pressure, in. wc}$$

## Calculating Air Velocity with density correction (Actual)

$$V = 1096.7 \times \sqrt{VP/D}$$

$$V = \text{Velocity, ft/minute (fpm)}$$

$$VP = \text{Velocity pressure, in. wc}$$

$$D = \text{Density, lbs/ft}^3, 0.075 \times (530/460+T_{act}) \times (P_{act} / 29.92)$$

$$T_{act} = \text{measured dry bulb temperature of the actual airstream, } ^\circ\text{F}$$

$$P_{act} = \text{absolute pressure of the actual airstream, in. Hg}$$

## Calculating Air Flow (Standard, 70 °F @ 29.92 in. Hg)

$$Q = A \times V$$

$$Q = \text{ft}^3/\text{minute (CFM)}$$

$$A = \text{duct area (ft}^2\text{)}$$

$$V = \text{Velocity, ft/minute (fpm)}$$

## Calculating Air Flow with density correction

Correcting for standard cfm

$$SCFM = ACFM(530/(460+T_{act}))(P_{act}/29.92)$$

$$SCFM = \text{standard flow rate}$$

$$ACFM = \text{actual flow rate} = \text{measured flow rate}$$

$$T_{act} = \text{measured dry bulb temperature of the actual airstream, } ^\circ\text{F}$$

$$P_{act} = \text{absolute pressure of the actual airstream, in. Hg}$$

Correcting for actual cfm

$$ACFM = SCFM((460+T_{act})/530)(29.92/P_{act})$$

$$SCFM = \text{standard flow rate}$$

$$ACFM = \text{actual flow rate} = \text{measured flow rate}$$

$$T_{act} = \text{measured dry bulb temperature of the actual airstream, } ^\circ\text{F}$$

$$P_{act} = \text{absolute pressure of the actual airstream, in. Hg}$$

## Calculating % of Outside Air (%OA)

$$\% \text{ OA} = (\text{RAT} - \text{SAT}) / (\text{RAT} - \text{OAT}) \times 100$$

$$\text{SAT} = (\% \text{OA} \times \text{OAT}) + (\% \text{RA} \times \text{RAT}) / 100$$

$$\text{OAT} = (\text{SAT} \times 100) - (\% \text{RA} \times \text{RAT}) / \% \text{OA}$$

$$\text{RAT} = (\text{SAT} \times 100) - (\% \text{OA} \times \text{OAT}) / \% \text{RA}$$

$$\text{RAT} = \text{Return Air Temperature}$$

$$\text{SAT} = \text{Supply Air Temperature (or mixed air temperature)}$$

$$\text{OAT} = \text{Outside Air Temperature}$$

$$\% \text{RA} = \text{Percentage Return Air}$$

## Calculating Duct Pressure

$$VP = TP - SP$$

$$TP = VP + SP$$

$$TP = \text{total pressure, in. wc}$$

$$SP = \text{static pressure, in. wc}$$

$$VP = \text{velocity pressure, in. wc}$$

## Using Fan Laws to Assess Performance Changes

$$CFM_2 = CFM_1 \times (RPM_2 / RPM_1)$$

$$SP_2 = SP_1 \times (CFM_2 / CFM_1)^2$$

$$BHP_2 = BHP_1 \times (CFM_2 / CFM_1)^3$$

$$CFM_1 = \text{Cubic feet minute (Existing)}$$

$$CFM_2 = \text{Cubic feet minute (New)}$$

$$SP_1 = \text{Static pressure (Existing)}$$

$$SP_2 = \text{Static pressure (New)}$$

$$BHP_1 = \text{Power consumed by propeller (Existing)}$$

$$BHP_2 = \text{Power consumed by propeller (New)}$$

**Recommended maximum duct velocities**

Application	Main Ducts*		Branch Ducts	
	Supply (fpm)	Return (fpm)	Supply (fpm)	Return (fpm)
Apartments	1000	800	600	600
Auditoriums	1300	1100	1000	800
Banks	2000	1500	1600	1200
Hospital Rooms	1500	1300	1200	1000
Hotel Rooms	1500	1300	1200	1000
Industrial	3000	1800	2200	1500
Libraries	2000	1500	1600	1200
Meeting Rooms	2000	1500	1600	1200
Offices	2000	1500	1600	1200
Residences	1000	800	600	600
Restaurants	2000	1500	1600	1200
Retail Stores	2000	1500	1600	1200
Theaters	1300	1100	1000	800

\*Use branch duct values when sound control is critical  
 Courtesy of TABB (Testing, Adjusting and Balancing Bureau)

**Typical design air velocities**

Air path element	Face velocities (fpm)
Outdoor Air Intake*	400 (7000 cfm and greater)
Exhaust*	500 (5000 cfm and greater)
Throw-Away Filter	200-800**
Heating Coil (Steam / Hot Water)	400-500 (200 min., 1500 max.)
Cooling Coil	500-600
Face 30/30	400-600
Return Through Undercutting of Door	200-300

\* Velocities for louver net free area; remaining velocities for total face area  
 \*\* 300 fpm typical upper limit for most inexpensive throw-away filters  
 Courtesy of TABB (Testing, Adjusting and Balancing Bureau)

**Performing duct traversals**

For maximum airflow accuracy, several readings must be taken across a traverse plane, converted to velocity, then averaged. The illustration in Figure 1 shows the points along the traverse plane where measurements should be taken, either in rectangular or circular ducts.

- A minimum of 25 points must be measured in a rectangular duct traverse.
- When traversing a duct side less than 18 in. (450 mm), take readings from the center of equal areas that are no more than 6 in. (150 mm) apart, with a minimum of two points per side of the duct.
- The preferred location of the traverse in a supply duct should be in a straight section of duct with 10 straight duct diameters upstream, and 3 straight duct diameters downstream of the traverse plane, although a minimum of 5 duct diameters upstream and 1 duct diameter downstream may give adequate results.
- When the traverse is located close to the fan, flow conditions are usually more favorable upstream on the return side. The traverse on the upstream side should be 0.5 duct diameters upstream of the fan inlet.

Equivalent diameter =  $\sqrt{4HV/\pi}$

H = horizontal duct dimension

V = vertical duct dimension

$\pi = 3.14$

**Helpful tips**

1. When performing a duct traverse, always ensure the nose of the Pitot tube is parallel to the duct wall and facing the airflow.
2. Take readings in long, straight runs of duct, where possible. Avoid taking readings immediately downstream of elbows or other obstructions in the airway.

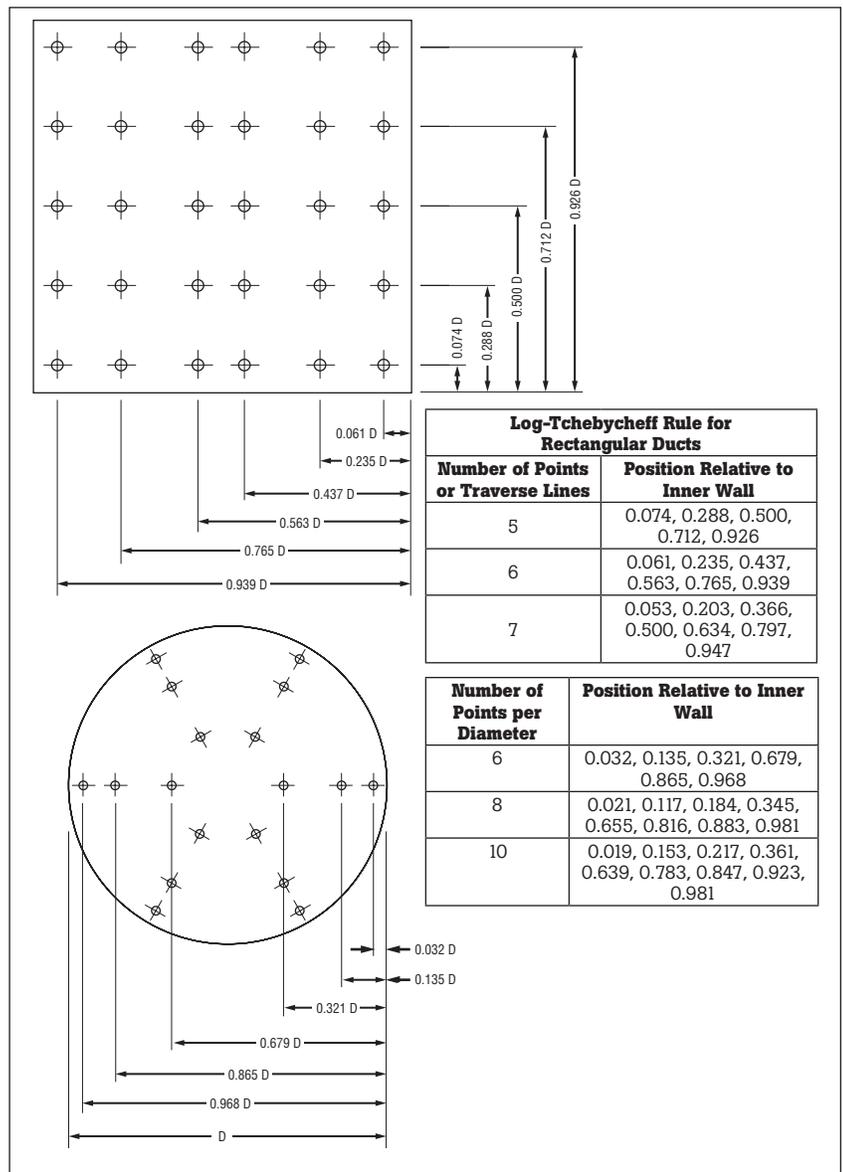


Figure 1. Measuring points and traverse lines for rectangular and circular ducts.

**Residential ventilation air requirements (cfm)**

ASHRAE 62.2-2004 recommends a mechanical exhaust, supply, or combination thereof be installed for each residence to provide outdoor air ventilation at rates no less than the following:

Floor Area (ft <sup>2</sup> )	Bedrooms				
	0-1	2-3	4-5	6-7	>7
<1500	30	45	60	75	90
1501-3000	45	60	75	90	105
3001-4500	60	75	90	105	120
4501-6000	75	90	105	120	135
6001-7500	90	105	120	135	150
>7500	105	120	135	150	165

Adapted from ASHRAE Standard 62.2-2004

- Assumes two persons in a one-bedroom dwelling unit, and an additional person for each additional bedroom.
- Increase ventilation rate by 7.5 cfm per additional person if higher occupant densities are known.