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MEASURING AIR FLOW
in Ducts, Pipes, Hoods and Stacks

Anemometers have traditionally been employed for air duct balancing. This cumbersome task requires performing a traverse of the opening, measuring and manually recording the velocity at numerous points, calculating the mean velocity, and then multiplying the mean velocity by the cross-sectional area of the duct or opening to obtain the total volumetric flowrate measurement in cubic feet per minute (CFM) flow rate.

With the newest microprocessor-based anemometers, up to a thousand data points can be stored in the memory for mean velocity calculation. Some units can even multiply the mean velocity by the cross-sectional area to give the readout in CFM. These capabilities provide tremendous new convenience for the HVAC professional.

TOTAL FLOW RATES

Total flowrate through an opening (Q in SCFM) is determined by the following relationship:

$Q = \overline{V}A$, where:

$\overline{V}$ = average velocity in SFPM (standard feet per minute), and
A = cross-sectional area of duct or pipe (in ft^2).

To determine the average velocity $\overline{V}$, divide the opening into a number of equal areas. Take a velocity reading at the center of each area and numerically average the results. If the velocity profile is relatively flat, only a few equal areas are needed. If the profile is non-uniform, several equal areas should be used. Generally, it is a good idea to make a rapid traverse across the duct in two dimensions to determine the uniformity of the air velocity. If the velocity is not constant at one measuring point, use the mean velocity between the upper and lower readings. Generally, the velocity profile is more uniform on suction openings than on supply openings. If a supply opening is covered by a grille, the probe should be placed about 1" in front of the grill to obtain the average velocity reading as above.

If information is given on the coefficient of discharge for a specific grille, the probe should be placed against the grille and centered over the open areas in the grille.

Choose several grille openings through which to obtain an average air velocity. In this case, the total flow is:

$Q = K\overline{V}A$, where:

K = the given coefficient discharge

A = the area of the grille as specified by the manufacturer

If a return or suction opening is covered by a grille and it is necessary to compute the total flow into the opening, take a number of readings at the centers of equal areas, as in the case where there is no grille, and determine the average velocity. The probe should be placed in the plane of the opening and close to the grille. The flowrate can be computed fairly accurately with the following equation:

$Q = FA\overline{V}$, where:

F = application factor (see table below)

A = designated area in square feet

Grille Type	Application Factor, F	Designated Area
None	1.00	Full duct area
Square Punched	0.88	Free (daylight) area
Bar	0.78	Core Area
Steel Strip	0.73	Core Area

For applications requiring higher accuracy, it is suggested that a duct extension be used having a length at least as great as the largest dimension of the grille. This duct extension is placed against the grille, and the procedures for an open grille are followed to compute flowrate. For highest accuracy, a smoothly tapered flow nozzle should be placed over the supply grille. In this case, the velocity profile at the exit jet of such a nozzle is very flat.

Duct Traversing

The log-linear method provides high accuracy (±3%) in flow totalization by taking into consideration the effect of friction along the walls of a duct. For round ducts, the three-diameter, six-point method is the preferred traverse. If the three-diameter method cannot be used (because of inaccessibility), then the two-diameter method is acceptable. This method consists of taking two sets of ten readings, 90° apart.

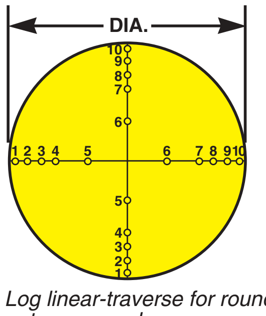

Figure 1. Log linear-traverse for round ducts, three-diameter approach.

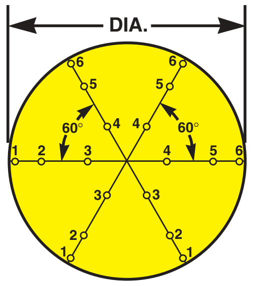

Figure 2. Log-linear traverse for round ducts, two-diameter approach.

With rectangular ducts, the following procedure is recommended:

1.The table below indicates that any rectangular duct dimension less than 30" requires five traverse lines on that side. Thus, a 28 x 20" duct will require 25 readings, because each side needs five traverse lines. A 38 x 20" duct will require 35 readings (seven traverse lines on the 38" side and five on the 20" side).

Duct Side Dimension	Number of Traverse Lines
< 30"	5
>30" but < 36"	6
>36"	7

2. The minimum number of readings should be 25.

3. The points where the readings are to be taken should be located at the intersection of the traverse lines as shown (as proportions of the traverse measurement) below:

No. of Traverse Lines		
5	6	7
0.074	0.061	0.053
0.288	0.235	0.203
0.500	0.437	0.366
0.712	0.563	0.500
0.926	0.765	0.634
	0.939	0.797
		0.947

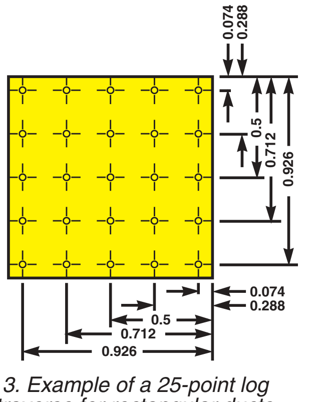

Figure 3. Example of a 25-point log linear-traverse for rectangular ducts.

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