

Residential Ventilation Issues

by Dara Bowser & Bob Allison

Duct Sizing Myths & Mysteries

NOT SMALLER THAN Manufacturer's Recommended Minimum Size

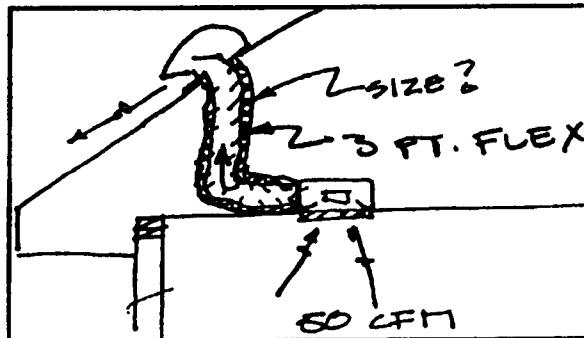
The phrase "...but, in any case, they shall not be smaller than recommended by the manufacturer." occurs in sentence 9.32.3.4.(9) as it applies to principal fans, sentence 9.32.3.5. as it applies to supplemental fans, and sentence 9.32.3.7.(5) as it applies to Heat Recovery Ventilators. This phrase only applies in the case where the duct for a fan is *smaller than the outlet size of the fan*. This often occurs with range hoods where a 4" dia. duct is improperly used. The outlet size for most range hoods is 3-1/4" x 10" or 7" dia. and any reduction below this size will result in reduced capacity. **Note: Vinyl (combustible) flex duct must never be used to duct range hoods.**

In general, the outlet size of the fans is the minimum size of duct recommended for that fan by the manufacturer. This phrase maintains the "manufacturer's recommended size" even if the code table allows a smaller size of duct than the outlet of the fan.

Fan-Outlet Size DOES NOT Dictate or Limit Proper Duct Size

The language used in section 9.32 does not prevent the use of a duct which is larger than the outlet size of the fan. For most exhaust fan ducts sized according to the 9.32 code tables, *the duct will be larger than the outlet of the fan*. A smooth increaser placed immediately at the outlet of the fan is all that is required to increase the duct diameter to the proper size.

This occurs because the rating system for fans is not based on outlet collar size. For example, a commonly used bathroom fan has an HVI rating of 90 cfm and an outlet diameter of 4". When operated at the rating point, the fan will produce 90 cfm with 20 feet of 4" diameter straight smooth duct connected. In reality, the system will have a wall-cap (equivalent length 60 ft) and elbows (equivalent length 10 ft each) and flex duct. The maximum system allowed for the use of table 9.32.3.D would result in a total effective length of 130 ft. (see example below). For this particular fan, the airflow connected to a 130 equivalent foot system of 4" dia. duct would be only 65 cfm. In order to actually deliver the 90 cfm listed on the label and in the HVI catalogue, the duct would have to be 6" dia.



Effective length is NOT the Same as Total Length

The building code allows sizing according to the tables in section 9.32 so long as the *total length* of the duct and the number of elbows or fittings is less than a specified value. Some fan manufactures' literature is supplied with curves of airflow plotted against *effective length*. In fact *effective length* and *total length* cannot be directly compared.

For example; sentence 9.32.3.5.(4) limits the *total length* of the duct to 30 ft. and the number of elbows to 4 in order to allow Table 9.32.3.D to be used. In fact, the effective length of this duct is 130 ft calculated as follows:

Wall cap	60 ft.
30 feet smooth duct.....	30 ft.
4 elbows @ 10 ft. each	40 ft.
<i>Total Effective Length 130 ft.</i>	

Increasing Duct Size DOES NOT Reduce Airflow

Increasing the duct size for any fan will reduce the *velocity* of air in a duct so that when you hold your hand in front of the outlet of the duct, the *apparent* airflow is less. In fact, the increased area of the duct results in an overall increase in airflow and the resistance to airflow is reduced because the *friction loss* of the air rubbing against the side of the duct is reduced. In general, a duct which is one diameter inch larger will have 50% less resistance to airflow than the smaller duct. In fact, increasing the duct size increases airflow for the system, even if the size is increased for only part of the system.

The Duct Sizing Tables in 9.32 Do Not Cover All Situations

The tables in section 9.32 are limited for the sake of simplification. Some situations where the 9.32 duct sizing tables cannot be applied are as follows:

- a) The 9.32 tables cannot be used if the principal exhaust fan or HRV high speed is **higher than the principal exhaust capacity**. Fan ratings are based on high speed operation and the tables are based on the *principal exhaust capacity*. If the tables are used, the system may not deliver the intended amount of air on any speed setting.
- b) Supplemental exhaust fans larger than 106 cfm cannot be sized using table 9.32.3.D. The table is for fans *up to* 106 cfm. Fans larger than this must be sized using part 6 methods.
- c) Any duct system which is longer, or contains more elbows than the limits set out in 9.32 must be designed according to part 6 methods.
- d) Ducts cannot be sized using the 9.32 tables for an airflow which is less than the "HVI rated capacity" of the fan. Undersized ducts will result in

fans delivering less than the HVI rated capacity, but the tables don't allow prediction of the actual airflow. To do this, a Part 6 design method must be used, together with fan data for a range of airflows.

Part 6 Duct Design Methods Are NOT Rocket Science

Part 6 duct design methods include those used by HRAI-certified Ventilation Installers and Designers. The same duct-sizing method is taught in the OBOA course "Residential ventilation for Building Officials". For a single exhaust fan, a "Part 6" duct design calculation may only take 5 minutes or less to complete. The HRAI Ventilation Manual contains several submittal worksheets (such as the one shown below) for single and branched duct systems that can be used to clearly set out the proposed installation and the expected performance.

**Dara Bowser is an HRAI Ventilation Instructor, an associate member of the CSA Technical Committee on Residential Mechanical Ventilation.
103041.3134@compuserve.com*

**Bob Allison is the Deputy Chief Building Official of the Regional Municipality of Haldimand-Norfolk.*

SINGLE-DUCT SIZING		W6D
1. EQUIPMENT FAN NO: <u>1</u> Make: <u>GENERIC</u> Model: <u>570</u> Design Airflow <u>50</u> cfm Equipment ESP <u>0.32</u> w.g.		2. INTAKE TOTAL EFFECTIVE LENGTH Actual length <u>3</u> ft Equivalent Length Outside Hood <u>60</u> ft • FLEX DUCT <u>3</u> ft • 90° FLEX. EL. <u>20</u> ft • 45° FLEX. EL. <u>10</u> ft _____ ft _____ ft Total Effective Length <u>96</u> ft
4. DUCT SIZE <u>4" dia. @ 0.32 w.g.</u>		
Sketch 		
Prepared by: <u>D. BUMSTEAD</u> HRAI # <u>V196-489</u>	Job name: <u>BUNGALOW</u> Date: <u>MAY 27/96</u>	Job # <u>7426</u> Official use: _____
HRAI © Copyright HRAI		Residential Ventilation WORKSHEET 60