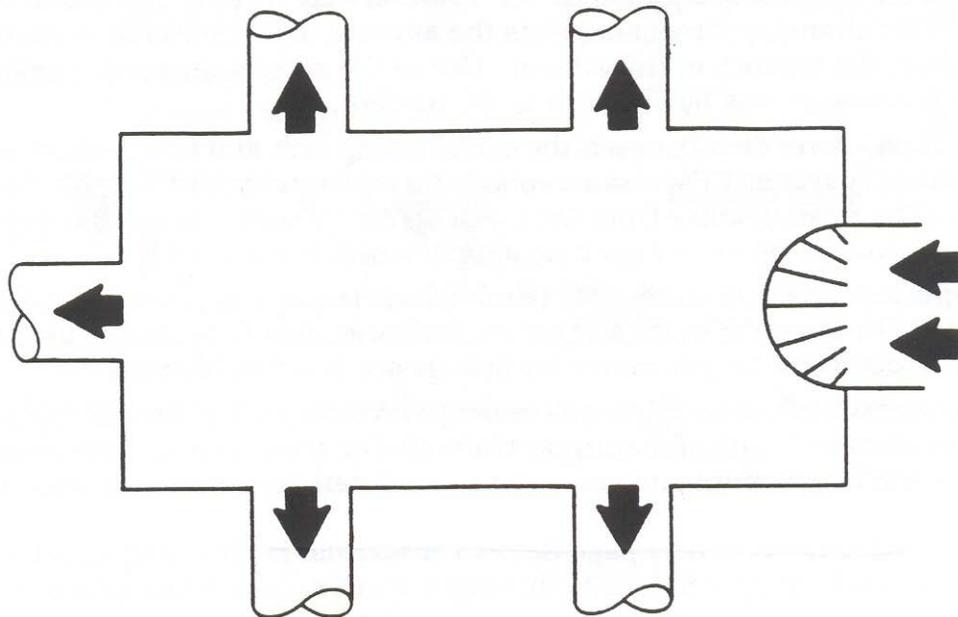


# TECH TIP # 42



One of a series of dealer contractor technical advisories prepared by HARDI wholesalers as a customer service.

## How to Properly Size Box Plenums (To be used with ACCA's Manual D)



A box plenum is a wide but short-length duct used to supply conditioned air to multiple branch ducts. The branch run-outs may be insulated flexible ducts or insulated round sheet metal pipes. The box plenum is frequently the principle supply plenum for a small residence, but may also be used in sub-circuits of larger distribution systems.

The design information outlined in this Tech Tip is based on research conducted at the University of Illinois. The results of that investigation showed the pressure loss imposed by box plenums was significant and must be considered in the overall system design. It was also determined that a special splitter vane *entrance fitting* was necessary to eliminate unstable air rotation within the plenum and to keep plenum pressure loss to a reasonable value.

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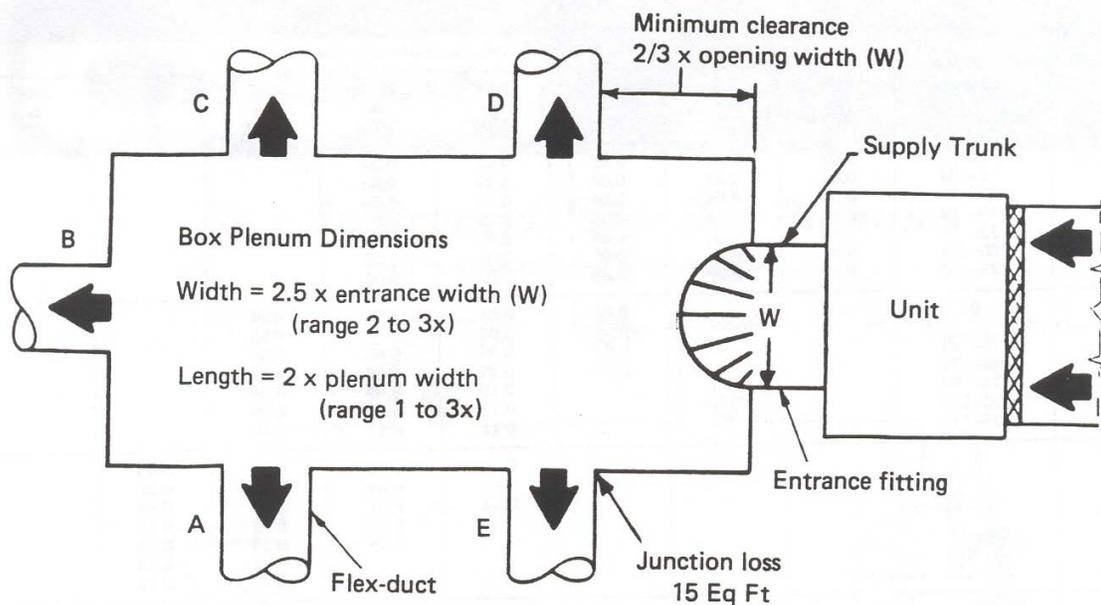
What follows is supplemental data to use with the Air Conditioning Contractors of America's (ACCA) Manual D duct sizing procedure. (You must be familiar with the procedures in Manual D or its equivalent to complete the design.) This tech tip provides a means to estimate the pressure loss of the box plenum in combination with any supply trunk between the conditioning unit and the box plenum. This loss can then be deducted from the total supply STAT as determined in Step J in the Manual D worksheet form D-1.

- Recommended box plenum proportions are listed in Figure 1. Optimum plenum width is 2.5 times the width of the connecting supply trunk or simply the width (W) of the entrance opening. Box plenum width may vary from 2 to 3 times the opening width. The preferred box plenum length is two times the plenum width, but may vary from 1 to 3 times the plenum width. Note minimum clearance requirement between first branch take-offs and the entrance to the box plenum.
- Figure 2 shows the construction dimensions for the special entrance fitting. Tests have shown that without this fitting, air will first rotate clockwise within the plenum. Then, with an off-on cycle of equipment, air rotation may reverse and rotate counterclockwise. This changing direction affects the amount of air delivered to each branch and can upset the balance in the system. Use of the special fitting also reduces the box plenum pressure loss by as much as 80 percent.
- Any supply trunk duct between the conditioning unit and box plenum is sized based on the supply system CFM and acceptable air velocity of from 700 to 900 feet per minute (fpm). (The relationship - Duct Area = CFM/Air Velocity - is used to determine trunk area or entrance opening area if no supply trunk is required.)
- The *effective* length of the supply trunk (if one is used) is determined based on the measured length of the trunk and the equivalent length of any fittings used in the supply trunk. (Equivalent length values for fittings are listed in Manual D.)

Example: A conditioning unit is to supply 850 CFM through a short supply trunk and box plenum with 9 run-outs. Figure 3 shows the arrangement. A supply trunk air velocity of 800 fpm is selected. The required trunk area is therefore  $850/800$  or 1.0625 sq. ft. Assume a 16 in. wide by 10 in. deep supply trunk is used. (This is also the size of the opening in the box plenum.) The measured length and fitting equivalent lengths of the trunk total 20 ft. In Table 1, the combined pressure loss for these flow conditions (follow arrows) is 0.6 in. WG.

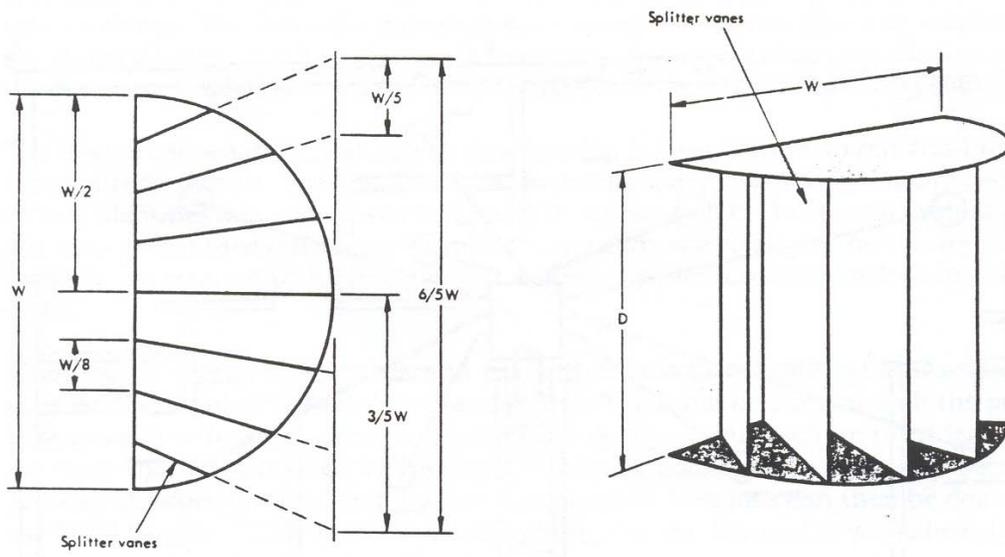
If, there was 0.10 in. WG available to size the entire supply system, then the pressure remaining to size the branch run-outs would be 0.10 minus the pressure obtained from Table 1. Thus,  $0.10 - 0.06$  or 0.04 in. WG remains to size each branch duct in our example.

Using a static pressure of 0.04 in. WG, each branch duct run would be sized based on the CFM through each run, its measured length plus the equivalent length of all the fittings used. (For the butt junction fitting connecting the branch to the box plenum, use 15 equivalent feet. See Figure 1.) Complete details on sizing branch runs are contained in Manual D.



**Figure 1 - Recommended Dimensions for an Efficient Box Plenum**

Using the recommended dimensions of Figure 1, the box plenum would be 2.5 x width of entrance opening (which is 16 inches) or 40 inches wide. The plenum length would be 2 x 40 or 80 inches long. Also, no branch connections would be made at any point on the box plenum that is within  $\frac{2}{3} \times 16$  or 10.67 inches of the entrance side. As a comparison, the minimum recommended plenum size would be -- width: 2 x 16 or 32 inches; length: 1 x 36 or 36 inches wide. The depth of the plenum is always the same depth as the supply trunk. Knowing the width (W) of the entrance opening (16 inches in our case), the entrance fitting can be constructed from the data in Figure 2.

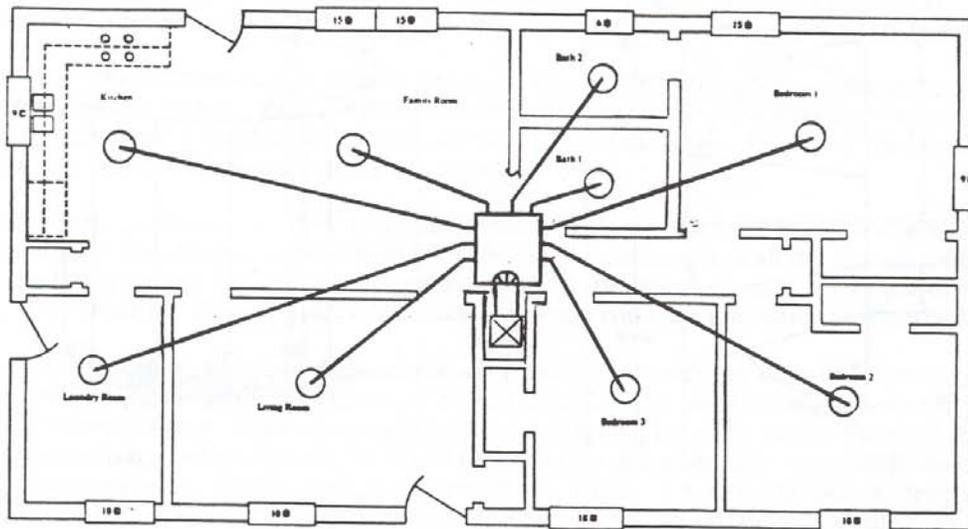


**Figure 2 - Recommended Entrance Fitting to Eliminate Unstable Air Flow in Box Plenum**

**Combined Pressure Loss of Trunk Duct and Box Plenum  
in inches of water**

Trunk Duct Velocity, fpm	Effective Length of Trunk Duct, ft.	Trunk Duct Capacity, cfm							
		600 to 700	700 to 800	800 to 1000	1000 to 1500	1500 to 2000	2000 to 2500	2500 to 3000	3000 to 4000
600	0	0.02	0.02	0.02	0.02	0.02			
	1- 24	0.03	0.03	0.03	0.03	0.03			
	25- 49	0.04	0.04	0.04	0.04	0.04			
	50- 74	0.05	0.05	0.05	0.05	0.04			
	75- 99	0.06	0.06	0.06	0.05	0.05			
	100-124	0.07	0.07	0.07	0.06	0.05			
800	0			0.04	0.04	0.04	0.04		
	1- 24			0.06	0.06	0.05	0.05		
	25- 49			0.08	0.07	0.07	0.06		
	50- 74			0.10	0.09	0.08	0.07		
	75- 99				0.10	0.09	0.08		
	100-124				0.11	0.10	0.09		
1000	0				0.06	0.06	0.06	0.06	
	1- 24				0.09	0.08	0.08	0.08	
	25- 49				0.12	0.11	0.10	0.09	
	50- 74					0.13	0.12	0.11	
	75- 99					0.15	0.13	0.13	
	100-124						0.15	0.14	
1200	0				0.09	0.09	0.09	0.09	0.09
	1- 24				0.13	0.12	0.12	0.12	0.11
	25- 49					0.16	0.15	0.14	0.13
	50- 74						0.17	0.17	0.16
	75- 99							0.19	0.18
	100-124								0.20
	125-150								0.22

**Table 1 - Pressure Loss of Box Plenum and Connecting Supply Trunk  
Recommended Trunk Velocity: For Residences - 700 to 900 feet per minute.**



**Figure 3 - Example Box Plenum System**