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Section 1

Basic Duct Sizing Principles

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Cfm	**Resistance (IWC)**
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1,650	0.23
1,700	0.14
1,750	0.04
1,800	—

Figure 1-1

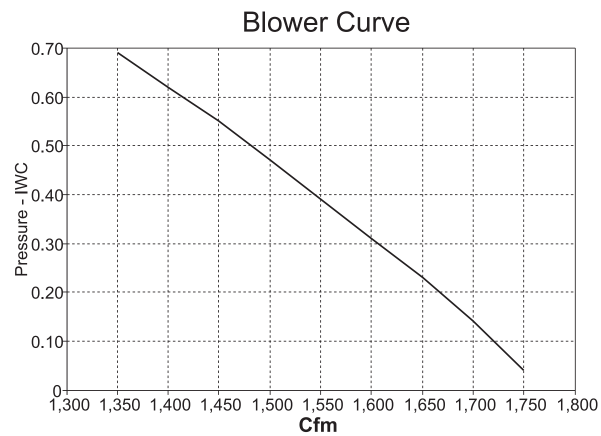

Figure 1-2

1-3 Duct Performance

Resistance is created when air is forced through a duct system. This resistance is caused by friction. Figure 1-3 provides an example of duct system performance. Notice that resistance increases rapidly as more air is forced through the duct.

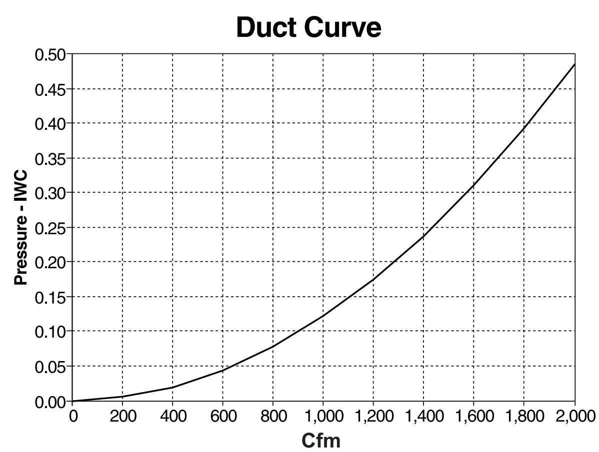

Figure 1-3

1-4 System Operating Point

If a blower (Figure 1-2) is connected to a duct system (Figure 1-3) there is only one possible operating point. Since this point must be compatible with blower performance,

Trunks	Cfm	FR	Diameter
Fan to S1	1,000	0.042	17"
S1 to S2	900	0.042	16"
S2 to S3	500	0.042	13"
Fan to R-1	1,000	0.042	17"
R1 to R2	300	0.042	11"
Runouts	**Cfm**	**FR**	**Diameter**
S1	100	0.042	7"
S2	400	0.042	12"
S3	500	0.042	13"
R1	700	0.042	15"
R2	300	0.042	11"
Sheet metal duct diameters rounded up to eliminate fractional dimensions.			

Figure 1-10

1-10 Pressure Drop for Air-Side Components

A resistance is created when air is forced through equipment or a device that is installed in the air stream; a filter, coil, damper, supply outlet or return grille, for example. This resistance translates to a pressure drop across the component. The size of this pressure drop depends on the flow (Cfm) through the component. Figure 1-11 provides an example of the air-side performance of an electric heating coil. Notice that the pressure drop increases rapidly as more and more air is forced through the coil.

1-11 Available Static Pressure

Component pressure drops are very important because the pressure dissipated by one or more items must be subtracted from the pressure that is available to move the air through the duct runs.

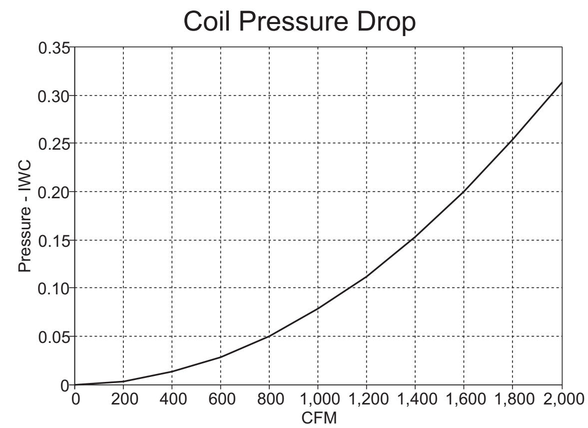

Figure 1-11

- Duct sizes are not based on the amount of pressure that the blower produces (i.e, the external pressure for the furnace or air handler), but on the net pressure that is available to move the air through the straight runs and the fittings.
- For a given amount of blower pressure, duct sizes have to be increased to compensate for the pressure dissipated by equipment and devices located in the critical circulation path of the duct system.

This concept is demonstrated by Figure 1-12. The blower still delivers 1,000 Cfm when working against 0.20 IWC of resistance, but 0.08 IWC of pressure is dissipated by the coil. Therefore, the only acceptable duct size is the size that produces a resistance of 0.12 IWC when the flow is 1,000 Cfm. Based on 0.12 IWC, the design friction rate is 0.025 IWC/100, and the size from the duct calculator is 18.6 inches. Notice that if no coil was installed, the duct size would have been based on 0.20 IWC of pressure, which would have resulted in a 0.042 IWC/100 friction rate and a 16.6 inch duct (see Section 1-8).

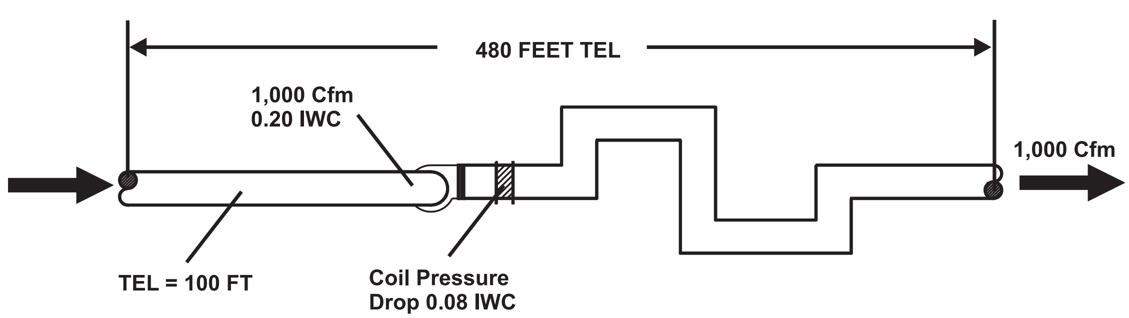

Figure 1-12

Section 8 — Illustrative Examples

Sizing Flexible Constant Volume Duct Systems

This section provides examples of airway sizing calculations for constant volume duct systems fabricated from flexible materials. These examples are for systems that comply with the required standard of care for installing flexible wire helix duct (see Section 4-3).

- Non compliant installations may have longer effective lengths and larger pressure drops.
- Appendix 17 provides tools for adjusting the effective length of systems that do not comply with the required standard of care for installing flexible wire helix duct.

The examples are for an extended plenum system that has a rigid trunk and flexible runouts, and a flexible wire helix system that has junction boxes. The standard ***Manual J*** procedure provides cooling load values for supply Cfm calculations (see Section 6-7, this manual).

Run	Length - Ft	H - Load	C - Load
1	22	3,810	3,110
2	15	3,800	2,380
3	12	3,970	3,200
4	15	4,250	2,750
5	12	3,860	3,010
6	15	4,500	2,610
7	22	4,590	3,500
8	16	4,870	3,750
9	15	2,350	1,690
R1	For supply runs 1, 2, 3, 4 and 5		
R2	For supply runs 6 and 9		
R3	For supply runs 7 and 8		

Figure 8-2

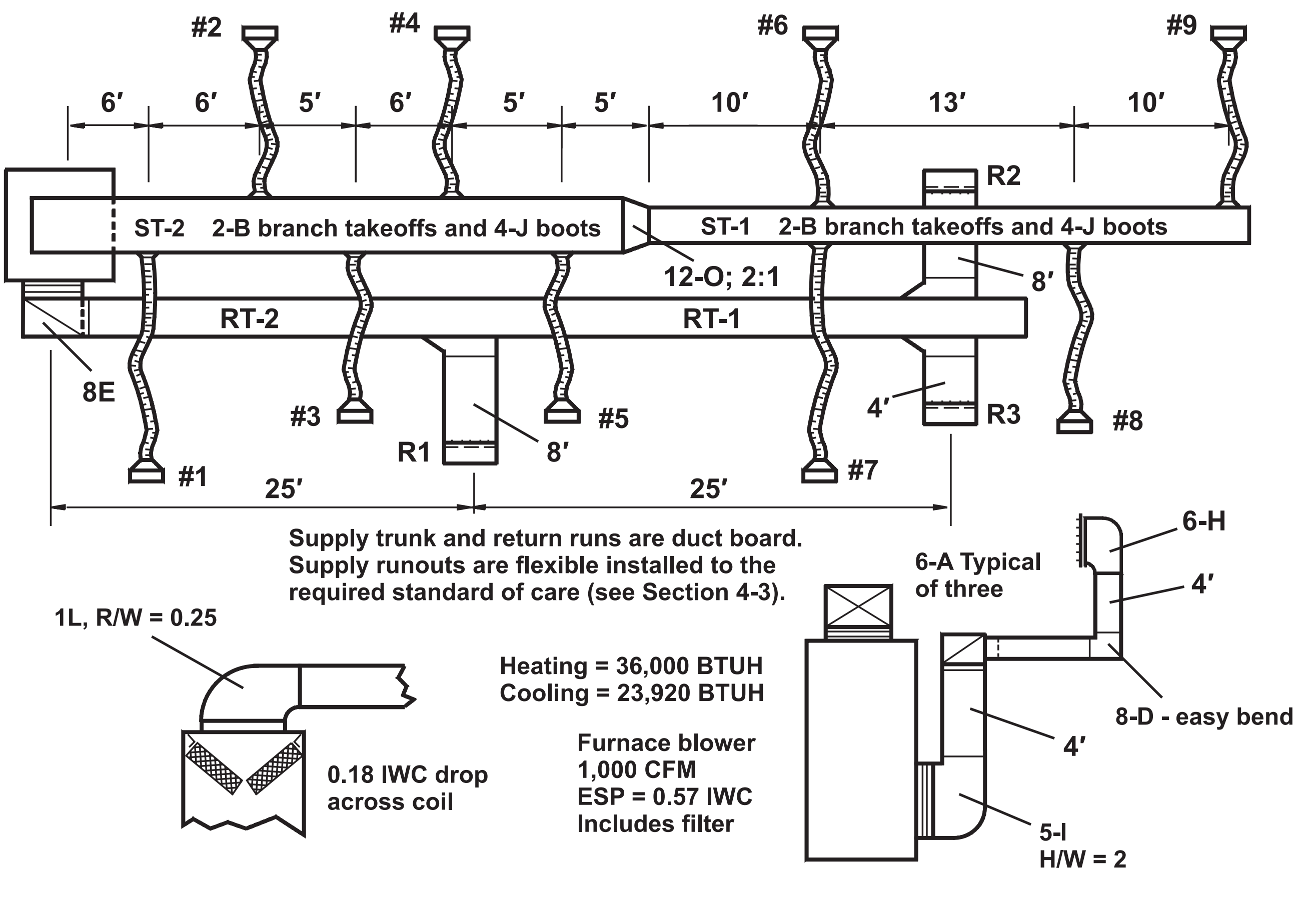

Figure 8-1

Bypass Damper Issues

When the bypass damper operates, the increment of air flow reduction shall be roughly the same for equal increments of damper movement. In other words, the bypass damper shall have a relatively linear response curve.

- Bypass damper response is more linear if there is a significant pressure drop across an open damper.
- To obtain a significant pressure drop, the free area of an open damper may be smaller that the flow area of the bypass duct.
- Damper engineering literature should provide tables or graphs that relate pressure drop to air velocity, and may provide percent flow vs. damper position graphs that show the response curve. Choose a size that has a roughly liner response curve and note the pressure drop for an open damper.
- If the bypass link airway size is larger than the bypass damper size, install gradual transitions before and after the bypass damper.
- Air velocity through the bypass damper may be significantly higher than air velocity through the bypass link airway. At some point the bypass damper may produce noise.
- Acceptable noise depends on the location of the bypass link in relation to the conditioned space.
- Noise will be reduced if the bypass link and transition fittings are fabricated from duct board or metal duct with duct liner, or flexible wire helix runs with duct board transitions.
- The goal is to obtain a fairly liner response curve without producing objectionable noise.
- The VAV control system shall co-ordinate the operation of the zone dampers and the bypass damper.

Bypass for True VAV Systems

A bypass route may or may not be required if blower Cfm is adjusted by speed control as VAV zone dampers close. This depends on how central heating and cooing equipment is affected by reduced air flow.

- The blower Cfm is reduced as VAV dampers close.
- The compressor and refrigerant coils may or may not have capacity control.
- An electric resistance heater may or may not have capacity control.
- A furnace burner may or may not have capacity control.
- Equipment may modulate, stage or cycle in response to programed VAV system control logic (recommended by ***Manual D***).
- Equipment may cycle on a low air flow switch or temperature limit control (not approved by Manual D).
- Capacity reduction capability and capacity controls determine the minimum air flow requirement for heating and cooling equipment.
- If a bypass route is required, follow the equipment manufacturer's sizing and installation instructions (see also, Appendix 16).

9-13 Control Dampers

The number of control dampers equals the number of zones. These devices may be installed in a branch runout duct (to control flow through a single supply outlet) or in a secondary trunk duct (to control flow through two ro more supply outlets).

If the control dampers modulate, they may feature an elliptical blade (in a round duct). This design is desirable because the performance curve (percent flow vs. percent open) is roughly linear.

Also note that controllability and sensitivity are affected by the pressure drop across an open damper. In this regard, an adequate pressure drop is obtained if air velocity through an open control damper ranges from 800 Fpm to 1,000 Fpm (this guidance is superceded by manufacturer's installation instructions).

Elliptical blades provide no benefit if simple open-shut control dampers are used. Round or rectangular blades will suffice. These dampers are sized so the air velocity through an open damper equals the air velocity in the upstream duct.

Installation details also are important. Use gradual transitions between the damper section and the upstream and downstream duct runs. Place the control dampers as far from a supply air grille as possible. (Control dampers generate noise when they are in the throttled position.)

9-14 Balancing Dampers

Hand dampers are useful for rough balancing. This way, the full throttling range of the operating dampers is available for temperature control.

9-15 Mixing Supply Air with Room Air

The supply air grilles and registers that are traditionally installed in residential duct systems are designed for constant air flow. The performance of these devices is compromised when they are used with a VAV system. For example:

Throws may be excessive when a zone operates at a maximum flow rate.

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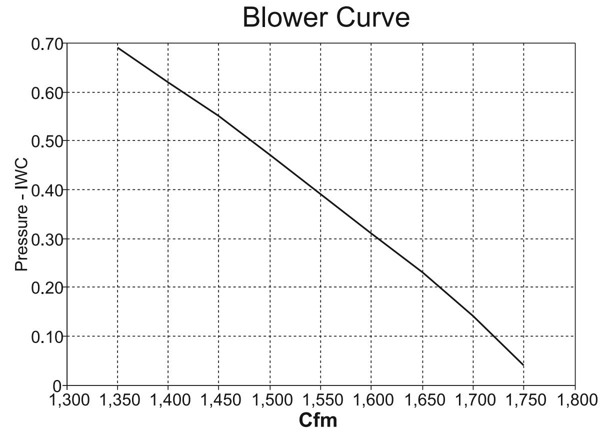

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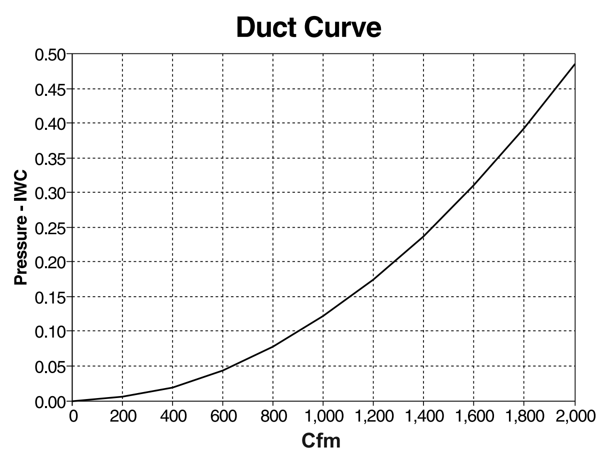

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