The Unico System®

TECHNICAL NOTE

Return Duct System Design Requirements

Introduction

The Unico System return duct system is a conventional duct system, only smaller because the system uses less air. It is not a high velocity duct system. Obviously, every system must have at least one return air register. In most cases, this is enough provided the single return is centrally located with a clear path for supply air to follow. Sometimes, however, multiple return openings are required by code or if the conditioned spaces are closed off from each other.

For example, in a typical residential application, a single return in ceiling of a central hallway is normally sufficient. On the other hand, if the system is conditioning separate rooms that are not open to one another, such as a multi-floor application with closed doors, or in a commercial application with individual offices, it will be necessary to use multiple returns – one in each of the separate spaces.

Scope

This Tech Note describes the requirements for designing the return system when a single ceiling mounted return is inadequate. To determine the duct size use the ACCA *Manual D* or the ASHRAE *Handbook — Fundamentals* and the requirements specified in this note.

Design Requirements

Unico has only two requirements:

1. **Pressure drop.** Design the return duct system pressure drop for 0.15 inches of water (37 Pa), including filters.
2. **Noise Attenuation.** Provide some means of acoustical dampening with no "line-of-sight" between the return opening of the air handler and the return grille. This usually means that you need to have at least one 90°F bend.

IMPORTANT

The duct pressure drop and the filter pressure drop added together must be less than 0.15 inches of water.

For most systems, the filter pressure drop is approximately 0.10 inches of water (25 Pa) and the duct pressure drop is 0.05 inches of water (13 Pa).

Duct Size - Single Return

As for any duct, size is dependent on duct length, air flow, and allowable static pressure drop. For most systems, the minimum duct size (see Table 1) is sufficient for up to 25 feet (8 m) with no more than three 90° bends.

Acoustical Flex Duct. The Unico return duct, UPC-04-xxxx, is an acoustical flex duct, 10 ft (3 m) long. This duct does an excellent job of absorbing sound from the blower. If you need a longer duct, add either another section of the Unico Return Duct or a length of plastic core flex duct between the unit and the Unico Return Duct.

Metal Duct. Metal return duct can be used provided it is lined with an acoustical lining. Fiberglass duct liner or acoustical roam rubber are typical for this application.

Fiberglass Duct Board. Fiberglass duct board is an excellent product. It provides good acoustical properties while maintaining excellent thermal resistance. Plus, it is very easy to install.

Plastic Flex Duct. It is possible to use plastic flex duct but this product does not attenuate the sound from the blower

Table 1. Minimum Duct Size

Model	Part No.	Diameter	Length
1218	UPC-04-1218	12 in. (305 mm)	10 ft. (3 m)
2430	UPC-04-2430	14 in. (356 mm)	
3642	UPC-04-3642	18 in. (457 mm)	
4860	UPC-04-4860	20 in. (508 mm)	
	UPC-04-4860NC	20 in. (508 mm)	

as well as the Unico acoustical flex duct. The main benefit of the plastic flex duct is that it is usually the least expensive option.

Duct Sizing – Multiple Returns

Determining the actual size of each return in a multiple return system is beyond the scope of this tech note. However, this is easy enough to accomplish using computer software, ACCA Manual D, or some other duct sizing calculator. Generally, if you are using a Duct Sizing Chart or calculator (such as the Trane Ductulator), size the return ducts for 0.05 inches/100 ft (0.40 Pa/m) based on the expected airflow through that return air duct. The total sum of air from all the returns should be at least 250 CFM/nominal ton (33 l/s per-kW).

Thermal Performance

If the duct system is installed in an unconditioned area, such as an attic or crawlspace, you should use a duct with at least an R-4.2 thermal resistance[1]. Some building codes may require a higher R-factor, such as R-6 or R-8.

Filter Size

The filter size is dependent on the type of filter and the amount of airflow. Typically, a disposable filter has the lowest pressure drop and an electrostatic filter has the greatest pressure drop (see Fig. 1). In some cases, it will be necessary to oversize the filter if it has a high pressure drop. Consult the filter manufacturer for the actual pressure drop at the required airflow. See *Tech Note No. 115* for various air cleaning devices for the *Unico System*.

Table 2. Minimum Filter Size

Model	Filter Size	Filter Type
1218	14 x 20 in. (356 x 508 mm)	Disposable
2430	14 x 25 in. (356 x 635 mm)	
3642	14 x 30 in. (356 x 762 mm)	
4860	24 x 30 in (610 x 762 mm)	
	20 x 30 in (508 x 762 mm)	

Sound Attenuation

Although the Unico air handler is quiet, noise from the blower can travel through the return duct and out the return register, especially when the return duct is short. To reduce the noise transmission, always use an acoustical type of return duct with the return register positioned to eliminate any direct "line-of-sight" from the unit.

The standard Unico Return Duct (see Table 1) has a soft porous lining that reduces the noise in the duct. As an alternate, construct the return duct out of fiberglass duct-

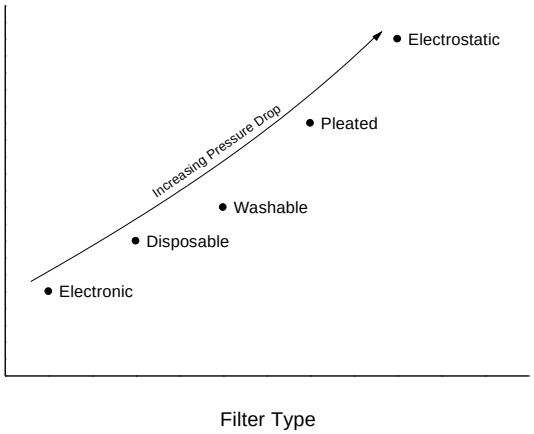

Fig. 1. Typical Filter Pressure Drop

board or a sheet metal with fiberglass duct lining. To prevent any direct line-of-sight add at least one 90-degree bend in the return.

Outside Air

The *Unico System* can accommodate up to 100 percent outside air provided the air is filtered and all water coils have freeze protection if necessary. Use the Unico Multiple Return Plenum Module, MRxxxx, as the transition plenum to combine the room air return and fresh air return, or for any combination of multiple returns. As an alternate, you can build your own a transition plenum with either fiberglass ductboard or lined sheet metal. (For more information, consult with Unico *Technote 105*.)

Humidifiers

In most applications, a power cold-air humidifier may be installed in the return duct system, or a steam humidifier in a metal supply duct. Other types of humidifiers should not be used, especially the bypass type or atomizing type. If using a powered cold air humidifier, install the unit onto the side of the return air module or build a return plenum to mount the humidifier. *Unico recommends consulting with the humidifier manufacturer on its intended usage prior to selecting the humidifier model and capacity.* Do not install a humidifier where freezing can occur unless the humidifier is designed for this purpose. See *Tech Note No.109*.

General Duct Design Practices

In addition to the Unico System specific rules in the previous paragraphs, the duct system should always follow basic engineering practices. The following guidelines should be followed whenever possible.

1. Multiple returns should be used when conditioning two or more spaces that do not communicate with each other. This is particularly important when heat-

[1] R-factor 1 ft^2-hr-°F/Btu = 0.176 m^2-K/W

ing and cooling separate floors with doors separating them.

2. Avoid creating a negative pressure zone near gas-fired equipment. As an example, do not put a return near a boiler or gas water heater. If the equipment is installed in a basement with a closed door, be sure to install a return for the first floor.

3. It is best to position the return high, near the ceiling, for cooling systems, and low, near the floor for heating systems. When heating and cooling, use two returns, one high and one low. If you can only use one, position it for the most important season. For example if cooling is more important than heating, position the return high. Recognize that one return is not as effective as two for heating and cooling systems

4. An open stairwell behaves like a chimney. Hot air will rise between floors so the heating load for the first floor will be higher than expected from a typical load calculation. Likewise, in cooling the upper floors will have a higher cooling load due to the chimney effect. In some cases, you may want to provide dampers on the returns to pull the air from the best location.

ADDENDUM

Door Undercuts

Q: Can I have central return rather than installing a complete return system with returns in each room?

A: Yes. This is acceptable for residential applications but not for commercial applications. You can use a central return located in a common area provided you have a minimum resistance circulation path between each room and the central return. You can achieve this by installing transfer grilles or undercutting the door, or both. The Unico System uses less air than a conventional system so that it is much more likely that a door undercut can be used without the need for a transfer grille. The rule for an undercut is very simple …

> **For every 30 CFM (1 outlets), increase the undercut by ½ inch.**
>
> **[For every 15 l/s (1 outlets), increase the undercut by 12 mm.]**

Code compliance. Door undercuts and transfer grilles are allowed in the Manual D (2nd Ed, 1995). The code explains in several places that this is acceptable if you have a minimal resistance path. However, Manual D does not specify a method for determining the size of the transfer grille or door undercut. Specifically, it says the following:

> **Section 1 Residential Air Distribution Systems**
> **Section 1-9 Return Air Paths**
> **Central Return**
> A single central return is the least expensive system to install. (In multilevel homes, a central return should be installed on each level.) Usually, the return duct is short; consequently, the return-side pressure drop is small. This type of return air system occupies a minimal amount of space, is easy to install and is inexpensive. The disadvantages of this system are that each isolated room must be equipped with an air transfer opening (grille or door undercut), equipment noise may not be effectively isolated from the living space and a large return air grille may be unattractive. (Page 1-14, ACCA Manual D)
>
> **Section 8 Duct Sizing Calculations**
> **Section 8-9 Return Branch Flow Rates**
> … Or, at the other extreme, there are no return branches associated with a system that features a central return. (Transfer grilles or door undercuts are required for isolated rooms that do no have a return.) In any case, the CFM that is associated with a particular return is equal to the total supply CFM that was delivered to the rooms or areas that are served by the return.

References. The formula for transfer grille openings is from the Building Science Corporation, which is based on the formula for a square-edged orifice with a 3 Pa pressure drop (http://www.buildingscience.com/documents/primers/bsp-050-design-process-for-sizing-cooling-and-heating-system-capacity-room-air-flows-trunk-and-runout-ducts-and-transfer-air-ducts). They also provide a simple web calculator at http://efficientcomfort.net/jsp/TGrilleSize_Web.jsp based on this formula, or you can use the following table.

Additional resources
There are numerous other resources available on the web that can be found by searching for "transfer grille sizing". Two of the best can be found at the following links:

http://www.eere.energy.gov/buildings/info/documents/pdfs/air_dist_sys_design-0782.pdf

http://www.hgtvpro.com/hpro/bp_mechanical/article/0,2617,HPRO_20151_4583393,00.html

The second link argues, rather convincingly, that a central return is a better system than a multiple return system.

Table A-1. Door undercut size (inches) required to meet minimum resistance requirement of Manual D.

Actual CFM	Door Width, inches				
	28	**30**	**32**	**34**	**36**
20	0.4	0.4	0.3	0.3	0.3
25	0.5	0.4	0.4	0.4	0.4
30	0.6	0.5	0.5	0.5	0.4
35	0.7	0.6	0.6	0.6	0.5
40	0.8	0.7	0.7	0.6	0.6
45	0.9	0.8	0.8	0.7	0.7
50	1.0	0.9	0.8	0.8	0.7
55	1.1	1.0	0.9	0.9	0.8
60	1.2	1.1	1.0	1.0	0.9
65	1.3	1.2	1.1	1.0	1.0
70	1.3	1.3	1.2	1.1	1.0
75	1.4	1.3	1.3	1.2	1.1
80	1.5	1.4	1.3	1.3	1.2
85	1.6	1.5	1.4	1.3	1.3
90	1.7	1.6	1.5	1.4	1.3
95	1.8	1.7	1.6	1.5	1.4
100	1.9	1.8	1.7	1.6	1.5
105	2.0	1.9	1.8	1.7	1.6
110	2.1	2.0	1.9	1.7	1.6
115	2.2	2.1	1.9	1.8	1.7
120	2.3	2.2	2.0	1.9	1.8

Ref: Building Sciences Corporation, Westford MA
http://www.bestofbuildingscience.com/pdf/509a3_cooling_system_sizing_pro.pdf

Table A-2. Door undercut size (mm) required to meet minimum resistance requirement of Manual D.

Actual l/s	Door Width, mm				
	700	**750**	**800**	**850**	**900**
10	10.5	9.8	9.2	8.7	8.2
12	12.6	11.8	11.1	10.4	9.8
14	14.8	13.8	12.9	12.2	11.5
16	16.9	15.7	14.8	13.9	13.1
18	19.0	17.7	16.6	15.6	14.8
20	21.1	19.7	18.4	17.4	16.4
22	23.2	21.6	20.3	19.1	18.0
24	25.3	23.6	22.1	20.8	19.7
26	27.4	25.6	24.0	22.6	21.3
28	29.5	27.5	25.8	24.3	23.0
30	31.6	29.5	27.7	26.0	24.6
32	33.7	31.5	29.5	27.8	26.2
34	35.8	33.4	31.4	29.5	27.9
36	37.9	35.4	33.2	31.2	29.5
38	40.1	37.4	35.0	33.0	31.2
40	42.2	39.3	36.9	34.7	32.8
42	44.3	41.3	38.7	36.5	34.4
44	46.4	43.3	40.6	38.2	36.1
46	48.5	45.3	42.4	39.9	37.7
48	50.6	47.2	44.3	41.7	39.3
50	52.7	49.2	46.1	43.4	41.0

Ref: Building Sciences Corporation, Westford MA
http://www.bestofbuildingscience.com/pdf/509a3_cooling_system_sizing_pro.pdf