Zoning Design Guide

ZONE PERFECT PLUS

Cancels: AP17–2

AP17–5
8-00

NOTE: Read the entire instruction manual before starting the installation.

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INTRODUCTION

Zone Perfect Plus is a zoning system capable of providing zone control requirements for 2, 4, or 8 living or business areas. This system allows the home or business owner to control the living environment in an individualized way. The Zone Perfect Plus kit includes the User Interface, Equipment Controller, Remote Sensors, an Outdoor Temperature Sensor, and Leaving Air Temperature (LAT) Sensor. See Fig. 1 for components which make up an 8–zone kit.

This guide provides information to help you design a Zone Perfect Plus installation. It discusses general topics related to designing a zoning control system.

Use this guide to help you design a zoning system that will:

- Meet or exceed the expectations regarding the system's capabilities. This goal will result in improved customer perception of your company, as well as repeat business and referrals.
- Protect the heating and cooling equipment used in the system. This goal will result in improved system reliability, longer life of heating and cooling equipment, and reduced warranty costs.

To design a zoning system to perform well under all conditions, it is essential to view the system as a whole at the design stage, rather than to begin selecting and installing individual components without a careful assessment of how they will work together. Be sure to perform all of the Tasks described in this guide **before** you begin to install components.

OVERVIEW OF ZONING

Zoning systems bring the possibility of total comfort control to the occupants by providing the right amount of heating or cooling to each space. Comfort can be described as the absence of sensation. Ideally, a zoning system should keep the occupants of the space comfortable without them being aware of the system.

WHAT IS ZONING?

A zone is a conditioned space (one room or a group of rooms) that is separately controlled by its own sensor. There are as many sensors in a designed system as there are zones.

A zoning system is a heating and cooling control system that maintains each zone at a predetermined temperature set point and maintains the overall space at a predetermined humidity set point. In addition to meeting these basic goals, Zone Perfect Plus is designed to:

- Direct conditioned air proportionately based on the needs of each zone, so that the zone(s) with the greatest demand receive relatively more conditioned air.
- Keep the sound produced by the system low enough that occupants will not find it objectionable.
- Conveniently interface with and protect the system's heating and cooling equipment.
- Maintain at least the minimum airflow necessary to keep heating and cooling equipment running efficiently.

IS A ZONING SYSTEM RIGHT FOR THIS JOB?

When designing a zoning system, it is important to keep in mind what a zoning system can and can not do. A zoning system is only part of a complete heating and cooling system. A properly selected heating and cooling system has a limited heating and cooling capacity. **A zoning system may or may not increase the effective capacity. This depends on whether the system is being designed for comfort (no increase) or energy savings (some increase in overall effective system capacity).**

A zoning system reduces the effective size of the air distribution system as dampers are adjusted and closed to meet the needs of the zone. The primary challenge when designing a zoning system is to make sure that the air distribution system cannot become so effectively small that the reduction in airflow causes one of the following problems:

- Air noise or draft becomes excessive.
- The heating or cooling equipment is shut down because temperature limits are exceeded.
- The life of the equipment is reduced because of stresses related to excess temperatures.

The addition of a zoning system will not correct undersized duct problems. A zoning system will compensate for oversized ducts, but <u>might</u> make a bad situation worse in the case of undersized ducts. There are many ways to make a marginal duct system perform better. Most of these approaches involve changing ducts, registers, and/or heating or cooling equipment.

DESIGNING A ZONE PERFECT PLUS INSTALLATION

The main objective when designing a zoning system is to maintain at least minimum airflow through the system when only one zone requires conditioning, yet still provide sufficient airflow when all zones require conditioning. The tasks described below provide step-by-step instructions for designing an effective zoning system. These tasks are grouped in the following phases:

Assigning Zones

Task 1–Assess the goals for comfort and energy savings.

Task 2–Conduct a site survey and make preliminary zone assignments.

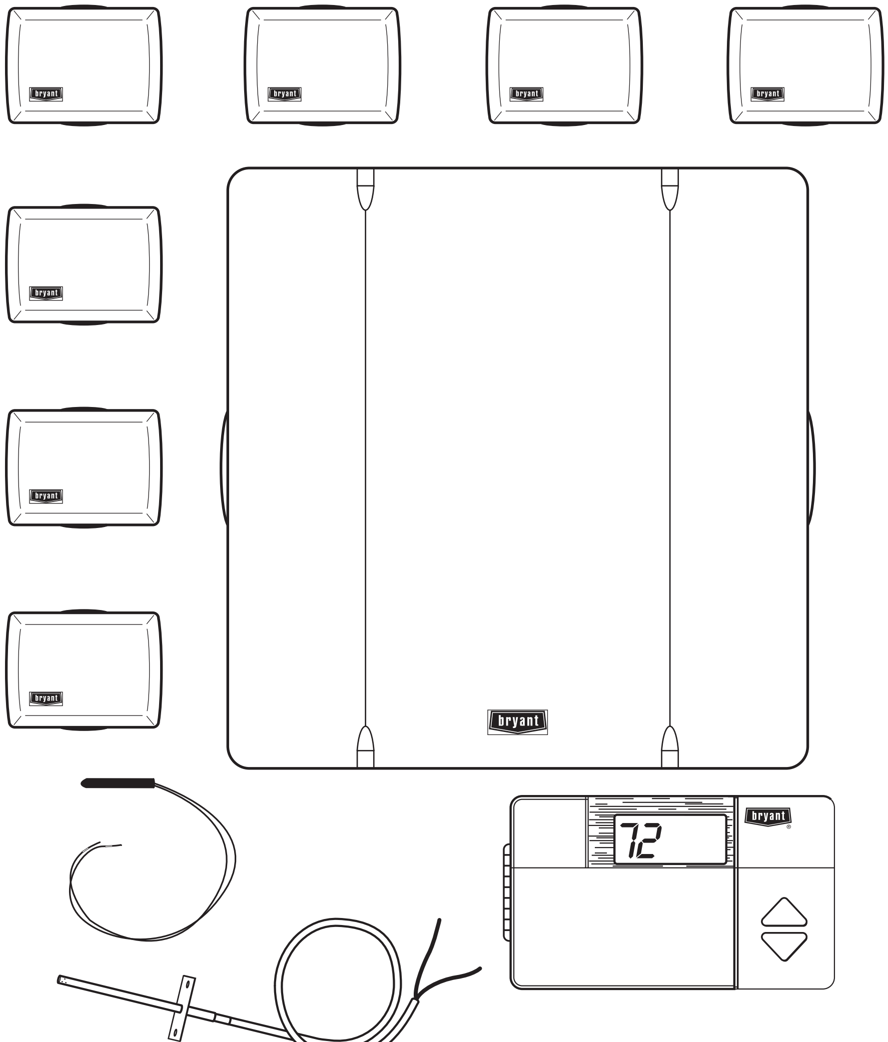

Fig. 1–Zone Perfect Plus 8 Zone Kit

Sizing the equipment

Task 3–Calculate block load estimates and zone load estimates.

Task 4–Size the heating and cooling equipment.

Sizing the duct system

Task 5–Determine bypass needs/options.

Task 6–Explanation of the Duct Sizing Worksheet.

I. ASSIGNING ZONES

A. Task 1–Assess the goals for comfort and energy savings

For a zoning system to be successful, it must meet the customer's goals for comfort and/or energy savings. Therefore, it is essential to understand the goals before beginning to design the system. In some situations, a customer's expectations might not be realistic and it would be impossible to design a system to meet those expectations. By identifying this problem from the start, you can help revise these expectations and avoid creating a dissatisfied customer.

In addition to understanding the general goals for the zoning system, you need to understand exactly how each space/zone will be used. Use Owner Survey sheet provided. The appendix will help you gather information from the owner/customer.

B. Task 2–Conduct a site survey and make preliminary zone assignments

The purpose of conducting a site survey is to gather the information that you need to make zone assignments. Use the Floor Pan Worksheet provided in the Appendix. Follow these guidelines:

- Provide the rough dimensions of each area or room.
- Indicate the location and relative size of doors, windows, and skylights. In particular, identify any large glass areas (exceeding 30 percent of the wall area).
- Indicate any equipment that may add a sensible/latent load (Light Commercial: computers, copiers, and waiting rooms. Residential: hot tubs, etc.).
- Indicate whether any trees or buildings cast shade on any of the building's exposures.
- Indicate the orientation of the home/building so you can determine whether there are any rooms or areas facing south or west where solar heat load may be a factor when making zone assignments.

Considerations for a Retrofitting Installation

It is a far greater challenge to design a retrofitted zoning system than it is to design a system for a new home or office. For a zoning system to operate properly in a retrofitted installation, it usually is necessary to use one or more of the following approaches to compensate for an air distribution system that is too small for the zoning system:

- Modify the existing ductwork and dampers to handle additional airflow.
- Set mechanical minimum damper positions in some zones.
- Improve the home/building's insulation to reduce the demand for heating and cooling (load) so that lower capacity equipment can be used effectively in the installation.

- Use multi-stage heating and cooling equipment so the equipment capacity can match the load when only a limited number of zones require conditioning.
- Select an air handler that is designed to overcome the high static pressure in the ductwork and force more air through the system. ECM is a good choice.

When selecting the appropriate approach for a retrofitted system, be sure to inform the owner of the trade-offs between cost and comfort when comparing approaches.

Return-air Ductwork

The return-air system should be able to remove the same amount of air from each zone as was supplied to it. If each zone does not have its own return, then a cross-contamination of zone temperatures could occur. A good sizing method would be to size the return at least as large as the main trunk of that particular zone.

Making Preliminary Zone Assignments

The owner's/customer's goals regarding comfort and energy savings affect how many zones are appropriate for the system:

- In a system designed primarily for comfort, all zones usually have comfort set points that remain relatively constant and that have similar time schedules. Such a system may have a large number of zones (5 to 8) of a relatively small size.
- In a system designed primarily for energy savings, zones must be larger to guarantee proper airflow to the zones that need conditioning (occupied), while the remaining zones will be closed (unoccupied). Such a system generally must have a smaller number of zones of a relatively larger size. In this case, you must be careful not to "over zone" (i.e., assign too many zones).

When making zone assignments, use the information that you gathered when conducting the site survey. Group areas that:

- Are in use around the same time of day. For example, it often makes sense to assign all bedrooms to a single zone because they are occupied only during the night time when other rooms in the home are not occupied.
- Have similar heating and cooling needs.
- Are physically separated from other areas.
- Are on the same level of the home. For example, the rooms on the upstairs level often have a different heating and cooling demand when compared to rooms downstairs. The differences can be due to the tendency for heat to rise, different use or occupancy, and the roof heat load.
- Have similar exposures to external heating gains and losses. For example, it often makes sense to assign rooms with large amounts of glass and western or southern exposure to the same zone.

If possible, discuss these considerations with the owner. Get the owner's input before making initial zone assignments. Mark your preliminary zone assignments on the Floor Plan Worksheet provided in the Appendix. At this point, consider your zone assignments to be preliminary.

II. SIZING THE EQUIPMENT

A. Task 3–Calculate block load estimates and zone load estimates

Using the information that you gathered in Task 2, calculate both heating and cooling load estimates (block load) for the entire home/building.

The standard Btu load calculations used for non-zoned systems apply equally well to zoned systems. Use a reliable method with which you are comfortable. This information will be submitted in Step 1 of the Duct Sizing Worksheet.

Next calculate individual "room-by-room" heating and cooling load estimates (in Btu's) for the home/building. This information will be submitted in Step 2 of the Duct Sizing Worksheet. Then, tentatively choose zone loads by adding rooms together and writing them into Step 3 of the Duct Sizing Worksheet.

The zone load estimates are used to determine whether the zone assignments you have make sense. They are also used to size the zone dampers and ductwork.

B. Task 4–Size heating and cooling equipment

Zone Perfect Plus is designed for use with residential furnaces, fan coils and light commercial products. Whenever possible, a thermostatic expansion valve (TXV) should be used. Zone Perfect Plus is designed to operate with equipment in a range of 1.5 to 12.5 tons in cooling mode.

How to determine the appropriate size of heating and cooling equipment is a challenge that is subject to many debates. In a zoning system, there is a very good possibility that a system will use all zones on a given day. For that reason, we recommend that you select the size of heating and air conditioning units based on either the home's/building's block heating load or block cooling load. Select the size of the air handling unit based on the load with the largest required CFM (heating or cooling CFM, whichever is larger). However, because the zoning system has the capability to not condition some zones at any given time, and because it is essential to maintain minimum airflow through the system at all times, it is better to use slightly undersized equipment than slightly oversized equipment in a zoning system.

Select heating and cooling equipment to meet the block heating and cooling block load estimates that you have written into Step 1 of the Duct Sizing Worksheet. Use the Product Data for the equipment that you are considering, determining whether the equipment can meet the system's needs. Verify that the selected indoor air handler can meet the heating and cooling airflow requirements. Write this information into Step 4 of the Duct Sizing Worksheet.

In a zoning system, it is especially important to select heating and cooling equipment that is **not too large.** Equipment that is larger than necessary compounds the problem of keeping the airflow in the system above the minimum required by the equipment when few zones require conditioning. Because the zoning system shuts down the equipment if the duct temperature falls outside the minimum or maximum temperature limits, and limits the number of times the equipment can restart to four times per hour, the actual capacity provided by the system can be smaller with larger equipment.

To help avoid such problems, size the equipment based on the calculated block heating and cooling airflow (whichever is larger) of the space. **Do not add a fudge factor.** Under even the heaviest loads, the system has the capability to send its entire capacity to less than the entire space. To redirect capacity where it is most needed, the owner can easily set back some zones.

Protecting equipment with a Zoning System

Any time zoning is applied to heating and cooling equipment, additional requirements **must** be performed. Variable-speed or multi-speed residential equipment must have the logic removed, which allows the zoning system to be in charge of staging.

Any cooling equipment that is going to run below its standard minimum outdoor temperature **must** have low ambient kits and wind baffles installed. Freeze-stats are required to protect the equipment in the case the Leaving Air Temperature (LAT) sensor cannot react quickly enough or has been disabled. For residential equipment, consult the Application and Service manuals for the required accessories. For Light Commercial (Tyler) products, see the Product Data for the descriptions of the freeze-stats, wind baffles, and MotorMaster options. When matched with zoning, varying speed condensor motors are recommended over the less expensive fan cycling controls.

III. SIZING THE DUCT SYSTEM

A. Task 5–Determine bypass needs

A way of bypassing air in the worst-case scenario (only one room zone open while the other zones are closed) needs to be considered. Traditionally, a Barometric Bypass has been the only option.

Direct bypassing only slows the inevitable, the bonnet/plenum temperature will get too hot or cold and eventually shut down the equipment. Barometric Bypassing to an open ceiling or open foyer is another option. With this type of zoning system, there are some other options to Barometric Bypassing.

"Controlled Leakage" is a way to divert air to otherwise closed zones if the smallest zone is the only one open. Each damper motor has a setscrew to allow a MIN setting. By not allowing the damper to close all the way, we have created a controlled leakage. This works great for retrofit application, when ductwork may not be able to be oversized as much as needed.

"Out Zones" are another alternative to eliminating excess air. This principle works from the duct temperature. If the bonnet/plenum becomes too hot or cold, the system will open an "Out Zone".

Bottom Line: If the smallest zone plus any controlled leakage can not handle 60 percent of the nominal CFM, then some type of "Bypassing Option" must be considered. It may not be used very often, based on patented damper movement (the system tries to achieve setpoints in all the zones at the same time). When designing with comfort in mind, rarely will only one zone be open, while the others are closed. **Bypass Determination** will be completed in Step 5 of the Duct Sizing Worksheet.

Installation of the Bypass Damper can either be a "Direct-Return" or "Dump-Zone". (See Fig. 2 and Fig. 3.)

Location of the Bypass Damper is very important. Listed below are a few guidelines for proper location.

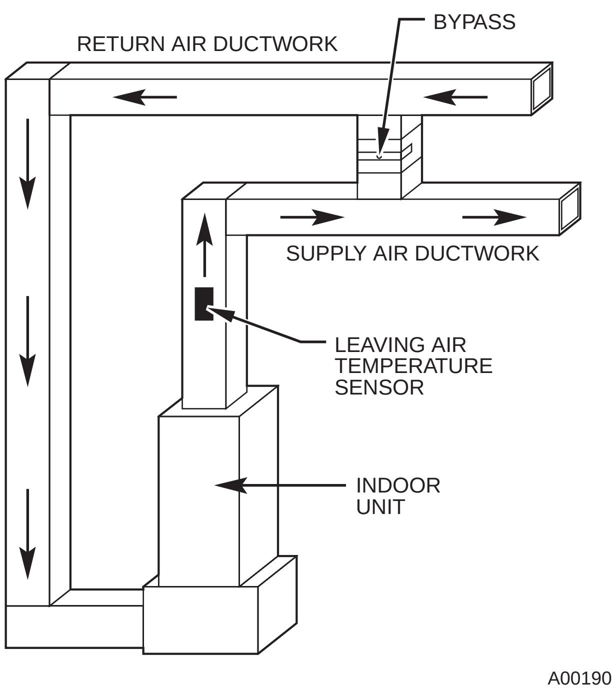

Fig. 2–Direct Return Installation

1. Location must be accessible for inspection and maintenance.
2. Location must be in an area that has allowed the airflow on the supply side to become smooth and allows bypassed air to mix with return-air, before entering the equipment.
3. The leaving air temperature (LAT) must be installed upstream (ahead of) from the bypass inlet.
4. Do not locate too closely to an open return. The bypassed air could cause the return to become positively pressured.
5. Consult Bypass Damper Installation Instruction for more information.

B. Task 6–Explanation of the Duct Sizing Worksheet

The Duct Sizing Worksheet will help size the supply ductwork for a zoning system. Traditional methods, whether zoning was being applied or not, have been to design duct work at .1 in. wc supply and .08 in. wc return. But not everyone knew that this was based on 100 ft of equivalent ductwork. Factoring in the equivalent lengths of fittings could cause the Total Equivalent Length (TEL) to go past 100 ft This could leave the ductwork undersized.

When zoning was to be applied to the system, we recommend 25 percent overissuing of the ductwork to handle the varying conditions of airflow in the system. Some distributors/dealers have a built-in "safety-factor" by designing the system with 30 percent oversizing. Other manufacturers of zoning products have recommended as much as 50–75 percent oversizing. In most cases, the oversizing took care of any TEL's over 100 ft.

The reason for this new Design Guide Worksheet is to help ease the fear of designing a zoning system. The way the worksheet is put together was to look at as many scenarios as possible, then apply three design techniques to each example. Each scenario was designed at:

1. 25 percent oversizing at .1 in. wc supply
2. 25 percent oversizing at .08 in. wc supply (to compensate for TEL over 100')
3. 30 percent oversizing at .1 in. wc supply (to compensate for TEL over 100')

In 99 percent of the applications, the ductwork sizes "crunched out" to the same size.

So, if you have designed a zoning system in the past, use this guide to see if the sizes match. If this if your first zoning design, have faith that the sizes are not too large. Our patented damper movement will adjust the airflow to where it's needed. If you are applying zoning to an existing duct system, compare what you have to what you need. Then make the necessary adjustments to the ductwork.

You should have completed Tasks 1–5 of the Duct Sizing Worksheet by following Tasks 1–5.

NOTE: The use of good take-offs and fittings are critical to the TEL of any ductwork system. Take-off and fitting Total Equivalent Length (TEL) examples are further explained in the Residential Air System Design (Catalog #791–443).

IV. REFERENCE FOR DUCT SIZING WORKSHEET: (SEE STEP 6 OF DUCT SIZING WORKSHEET, PAGE 9)

Using **Table 1** determine the minimum Main Duct square inches and the minimum Total Branch square inches by locating the desired Zone CFM (from Task 3) along the left-verticle column. If your desired Zone CFM falls between the listed CFM's, use the one closest to your calculated CFM. Follow the desired Zone CFM across until you reach the Equipment Capacity, along the top, required for your application. Write these values for each zone in the area provided in Task 6.

NOTE: If two or more zones share a main duct (see Fig. 6) then add the zone CFM's together and use that CFM to size the Main Duct. Then as each zone is "branched-off", it becomes the zone "Main Branch" and would be sized based on the individual zone square inches.

The listed areas (square inches) will provide a maximum zone duct pressure drop of approximately 0.1 in. wc / 100 ft and a maximum of 900 fpm for main ducts and 700 fpm for branch ducts for sheet metal ductwork. For "Duct board", multiply areas by 1.1, or for "flex-duct" multiply areas by 1.25 to maintain same duct pressure drop and fpm. If CFM in Step 3 is based on cooling and the design is NOT based on 400 CFM/ton, divide that CFM by 400. Multiply the areas by this number (Example: a system design of 350 CFM/ton of airflow, multiply areas by: 350/400 = .88).

NOTE: The "grey-shaded" boxes represent zone CFM's of less than 20 percent of the total CFM. The square inches were increased approximately 10 percent to help deal with situations where limited zones may be open.

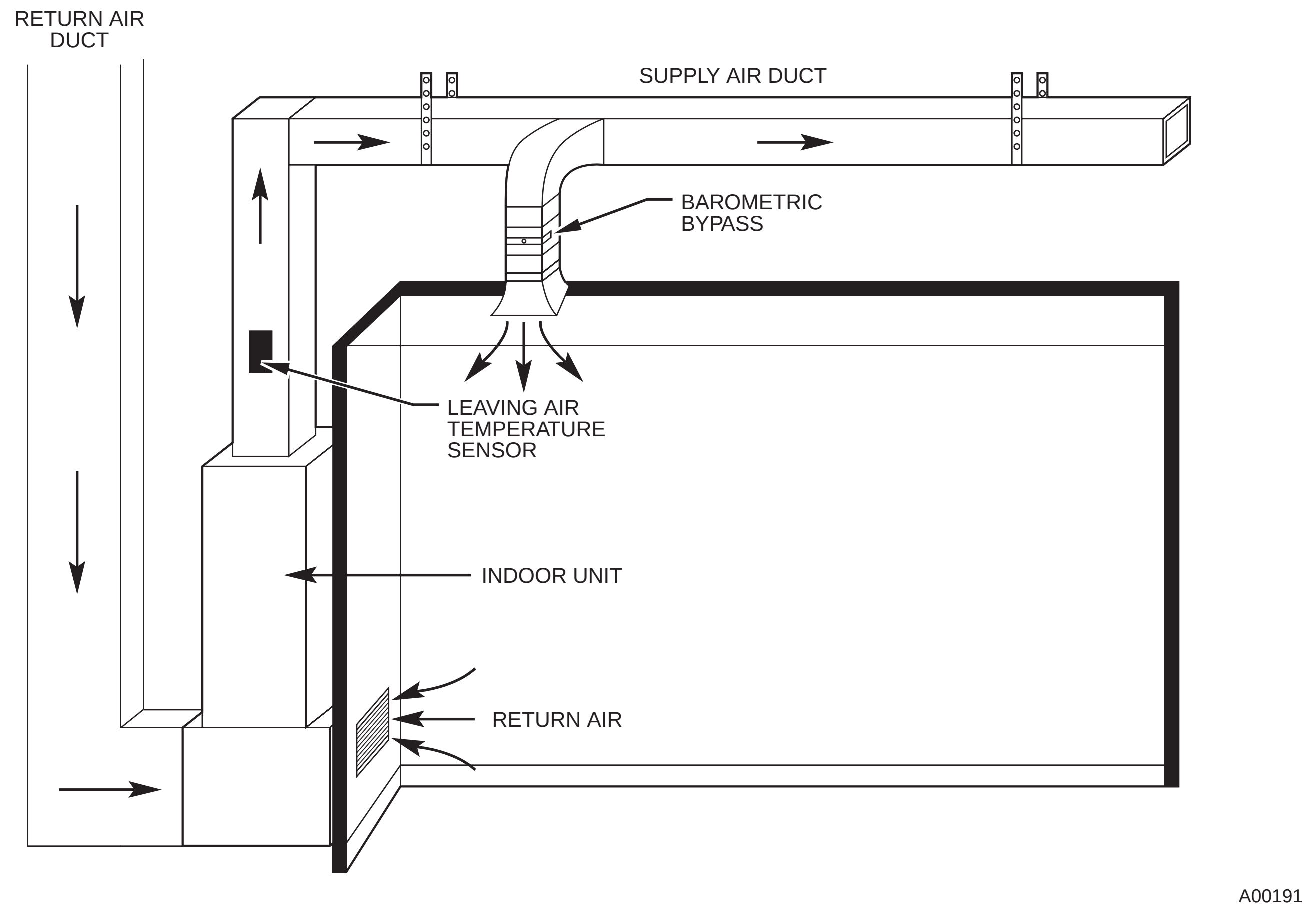

Fig. 3–Dump Zone Installation

V. REFERENCE FOR DUCT SIZING WORKSHEET: (SEE STEP 7 AT DUCT SIZING WORKSHEET, PAGE 9)

Using **Table 2A** locate the Minimum Main Duct Area from Step 6 (duct sizing worksheet) to determine the Main Duct size. Select a damper/duct size at least as large as the area required. Refer to the Product Data for sizes of dampers. If the Main Duct is split or runs in two directions, divide up the total zone CFM needed to each main, locate the square inch areas to meet the required CFM and then size the dampers.

Using **Table 2B** locate the Minimum Branch Area from Step 6 to determine the Branch Duct size(s). Any combination can be used, as long as the total of the Branch Duct area meets or exceeds the required amount.

APPENDIX

The following appendix provides worksheets for you to copy and use when designing a Zone Perfect Plus installation:

- Owner Survey
- Floor Plan Worksheet
- Duct Sizing Worksheet
- Examples

We will show three examples of the zoning design guide.

Example 1
Light Commercial — Doctor's Office
Heating Load: 125,000 Btu
Cooling Load: 115,000 Btu
Equipment selected: 581B120125

Example 2
Residential Ranch
Heating Load: 90,000 Btu
Cooling Load: 52,000 Btu
Equipment Selected: 355MAV060100 and 598B060

Example 3
Taking Example 2 and substitute Duct-Board as main and Flex-Pipe as branch runs. We will begin at Step 6.

Owner Survey

1. How many members are there in your household/building?

2. Describe the activities in your household on an unusual day. In particular, are there activities that might require extra cooling or heating?

3. Describe the typical usage of the various areas of your home/office throughout the day.

4. What areas, if any, in your home/office that are used infrequently, such as a formal dining/meeting room, or that are unoccupied for large periods of time during the day or night?

5. Is there an area in your home/office that will be used for physical activity?

6. Describe the entertaining that you do in your home:
   - How often do you entertain in the summer? In the winter?
   - During what times of the day do you typically entertain?
   - How many people do you usually entertain?
   - What areas of your home do you use when you entertain?
   - Are there times when people go in and out of the house frequently (for example, if you entertain outdoors)?

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7. What temperature do you normally want to maintain in your home/office during the day in the summer? The nights in the summer? The days in the winter? The nights in the winter?

____

8. Are there any times when you want significantly different temperatures in all or part of your home? If so, in what areas or rooms? How quickly do you want the temperature change to occur?

____

____

9. To what extent do you want to be able to control the temperature in your home?

____

10. What do you expect from your indoor comfort system?

____

____

Additional Questions for an Existing Home/Office Building

1. Are there any areas or rooms in your home/office that are too hot or cold in the winter? In the summer?

____

2. Do you have a humidity problem in your home/office? Too much? Too little?

____

3. How long do you plan to live in your present home?

____

4. What do you like about your present heating and cooling system? What do you dislike?

____

____

____

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Floor Plan Worksheet

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DUCT SIZING WORKSHEET

Step 1:Calculate Block Load

Heating Load:____________________ Btuh   Cooling Load:____________________ Btuh

Step 2:Room by Room Load

Room	Heating Load (Btuh)	Cooling Load (Btuh)	Airflow (CFM)*	Zone Number
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________
____________	____________	____________	____________	____________

*Highest CFM determined from Heat/Cool Btuh

Step 3: Zone CFM totals

Zone 1 ____________ CFM   Zone 5 ____________CFM
Zone 2 ____________ CFM   Zone 6 ____________CFM
Zone 3 ____________ CFM   Zone 7 ____________CFM
Zone 4 ____________ CFM   Zone 8 ____________CFM

Step 4: Equipment Selection

	Indoor Section	____________	Outdoor Section	____________
Heating Capacity/CFM		____________		____________
Cooling Capacity/CFM		____________		____________
Design CFM		____________		

Step 5: Bypass Determination

System Design CFM * ____________ X 0.60 = ____________

* Design CFM can be: Step 1C from above OR if Two Speed/Variable Speed equipment is selected, select low speed CFM value.

Step 6: Zone Minimum Area (sq. in.)(from Table 1, page 21)

	CFM	Main Duct (sq. in.)	Branch Area (sq. in.)
Zone 1	____________	____________	____________
Zone 2	____________	____________	____________
Zone 3	____________	____________	____________
Zone 4	____________	____________	____________
Zone 5	____________	____________	____________
Zone 6	____________	____________	____________
Zone 7	____________	____________	____________
Zone 8	____________	____________	____________

Step 7:Main Trunk (Table 2A) and Branch Duct (Table 2B) Sizes

Zone 1
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 2
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 3
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 4
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 5
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 6
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 7
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

Zone 8
Main Duct (sq. in.):_____________________ = Main Duct Size:____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =________________+
Size:__ Qty:___ Area (from Table 2B) =________________+
=________________ Total Sq. In.

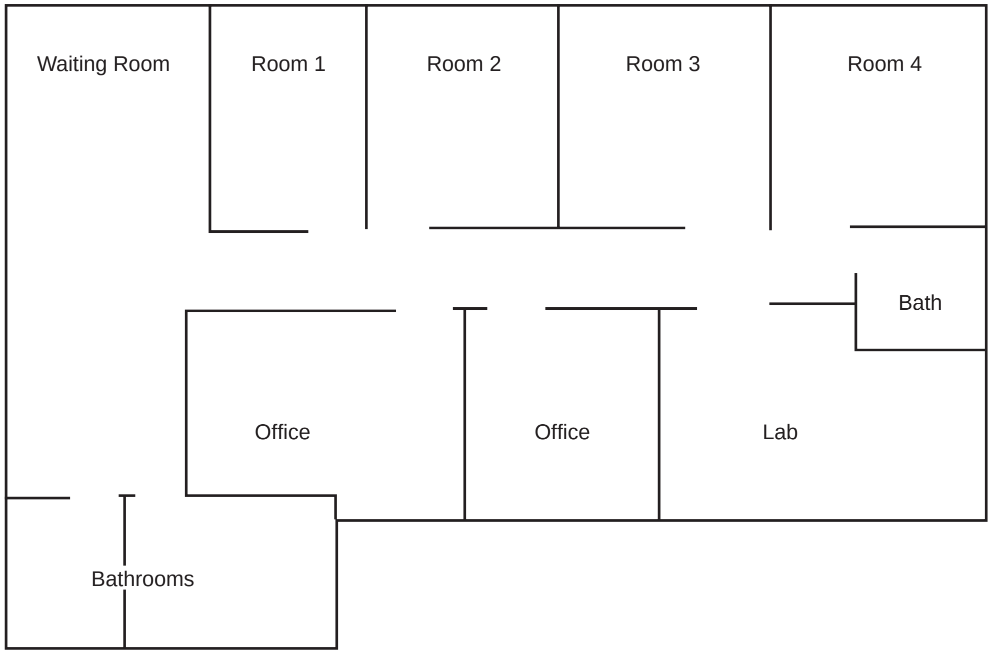

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Fig. 4–Light Commercial Application-Doctor’s Office (unzoned)

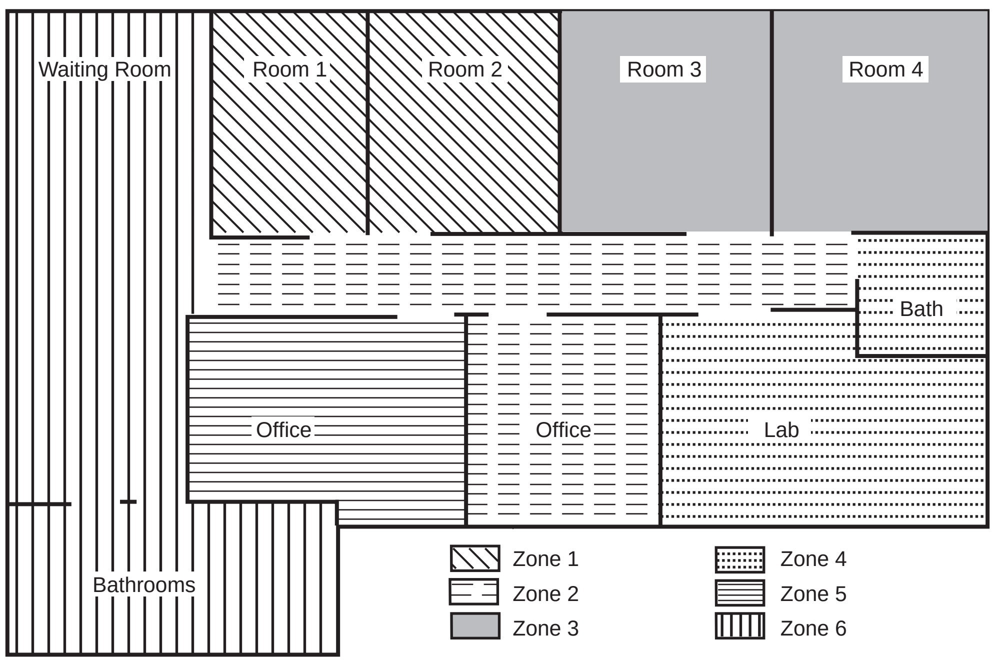

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Fig. 5–Light Commercial Application-Doctor’s Office (zoned)

DUCT SIZING WORKSHEET-EXAMPLE 1

Step 1:Calculate Block Load

Heating Load:______________125,000 Btuh   Cooling Load:_____________115,000 Btuh

Step 2:Room by Room Load

Room	Heating Load (Btuh)	Cooling Load (Btuh)	Airflow (CFM)*	Zone Number
Waiting Room			1,000	6
Room 1			250	1
Room 2			250	1
Room 3			250	2
Room 4			250	2
Back Bathroom			150	4
Lab			550	4
Office			600	3
Office/Restrooms			700	5

*Highest CFM determined from Heat/Cool Btuh

Step 3: Zone CFM totals

Zone 1 _________500 CFM
Zone 2 _________500 CFM
Zone 3 _________600 CFM
Zone 4 _________700 CFM
Zone 5 __________700 CFM
Zone 6 ________1,000 CFM
Zone 7 _____________ CFM
Zone 8 _____________ CFM

Step 4: Equipment Selection

	Indoor Section	Outdoor Section
	____________	______581B120
Heating Capacity/CFM	______125,000	_________4,000
Cooling Capacity/CFM	______115,000	_________4,000
Design CFM	________4,000	

Step 5: Bypass Determination

System Design CFM * 4,000________ X 0.60 = 2,400_________

(Value MUST be less than smallest zone CFM; otherwise Bypass Damper may be required)

* Design CFM can be: Step 1C from above OR if Two Speed/Variable Speed equipment is selected, select low speed CFM value.

Step 6: Zone Minimum Area (Sq.In.) (From Table 1)

Zone 1 CFM__ 500____	Main Duct __123___Sq.In.	Branch Area__179___Sq.In.
Zone 2 CFM__ 500____	Main Duct __123___Sq.In.	Branch Area__179___Sq.In.
Zone 3 CFM__ 600____	Main Duct __133___Sq.In.	Branch Area__208___Sq.In.
Zone 4 CFM__ 700____	Main Duct __154___Sq.In.	Branch Area__246___Sq.In.
Zone 5 CFM__ 700____	Main Duct __154___Sq.In.	Branch Area__246___Sq.In.
Zone 6 CFM_1,000____	Main Duct __189___Sq.In.	Branch Area__330___Sq.In.
Zone 7 CFM _________	Main Duct ________Sq.In.	Branch Area________Sq.In.
Zone 8 CFM _________	Main Duct ________Sq.In.	Branch Area________Sq.In.

Table 1
Zone CFM

Main Duct Area (sq.in.)
Equipment Capacity

Zone CFM		2	2.5	3	3.5	4	5	6	7.5	8	8.5	10
200	Main	57	57	57	64	64	64					
	Branch	66	66	66	75	75	75					
300	Main	79	79	79	79	79	87	87				
	Branch	99	99	99	99	99	110	110				
400	Main	86	86	86	86	86	86	104	104	104		
	Branch	132	132	132	132	132	132	140	140	140		
500	Main	113	113	113	113	113	113	113	123	123	123	123
	Branch	165	165	165	165	165	165	165	179	179	179	179
600	Main	123	123	123	123	123	123	123	123	133	133	133
	Branch	198	198	198	198	198	198	198	198	208	208	208
700	Main		143	143	143	143	143	143	143	143	154	154
	Branch		231	231	231	231	231	231	231	231	246	246

A00132

Zone 1 & 2

Main Duct Square Inches __ 123 ____ = Main Duct Size___8x18____
Branch Square Inches_____179__
Size__10"___Qty___2___ Area (from Table 2B)=__180___+
Size_______ Qty_______ Area (from Table 2B)=________+
=__180___Total Sq.In.

Table 2A Main Duct Sizing
Equivalent Areas for Ducts (sq.in.)

Duct Width	Duct Height (in.) 8	10	Round Dia-Inch	Sq.In.
8	60	80	8	50
10	80	87	10	79
12	90	110	12	113
14	105	135	14	154
16	115	157	16	201
18	125	167		

Zone 3

Main Duct Square Inches __ 133 ____ = Main Duct Size___10x14____
Branch Square Inches_____208__
Size__7"___Qty___2___ Area (from Table 2B)=__76___+
Size__8"___Qty___2___ Area (from Table 2B)=__135___+
=__211___Total Sq.In.

Table 2B Branch Duct Area (Sq.In.)

Quantity	Duct Diameter - in. 5	6	7	8	10
1	20	28	38	60	79
2	40	56	76	135	180
3	60	84	114	180	330
4	80	112	152	235	465
5	100	140	190	300	530
6	120	168	228	365	660
7	140	196	266	430	760
8	160	224	304	500	825

A00133

Zone 4
Main Duct (sq. in.):__________________154 = Main Duct Size:_______10x16
Branch (sq. in.):_____________________246
Size:8″ Qty:_3 Area (from Table 2B) =______________180+
Size:10″ Qty:__1 Area (from Table 2B) =_______________79+
=______________259 Total Sq. In.

Zone 5
Main Duct (sq. in.):__________________154 = Main Duct Size:_______10x16
Branch (sq. in.):_____________________246
Size:8″ Qty:__ 3 Area (from Table 2B) =______________180+
Size:10″ Qty:__1 Area (from Table 2B) =_______________79+
=______________259 Total Sq. In.

Zone 6
Main Duct (sq. in.):__________________189 = Main Duct Size:_______10x20
Branch (sq. in.):_____________________330
Size:10″ Qty:__3 Area (from Table 2B) =______________330+
Size:__ Qty:___ Area (from Table 2B) =_________________+
=______________330 Total Sq. In.

Zone 7
Main Duct (sq. in.):_____________________ = Main Duct Size:_____________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =_________________+
Size:__ Qty:___ Area (from Table 2B) =_________________+
=_________________ Total Sq. In.

Zone 8
Main Duct (sq. in.):_____________________ = Main Duct Size:___________
Branch (sq. in.):________________________
Size:__ Qty:___ Area (from Table 2B) =_________________+
Size:__ Qty:___ Area (from Table 2B) =_________________+
=_________________+ Total Sq. In.

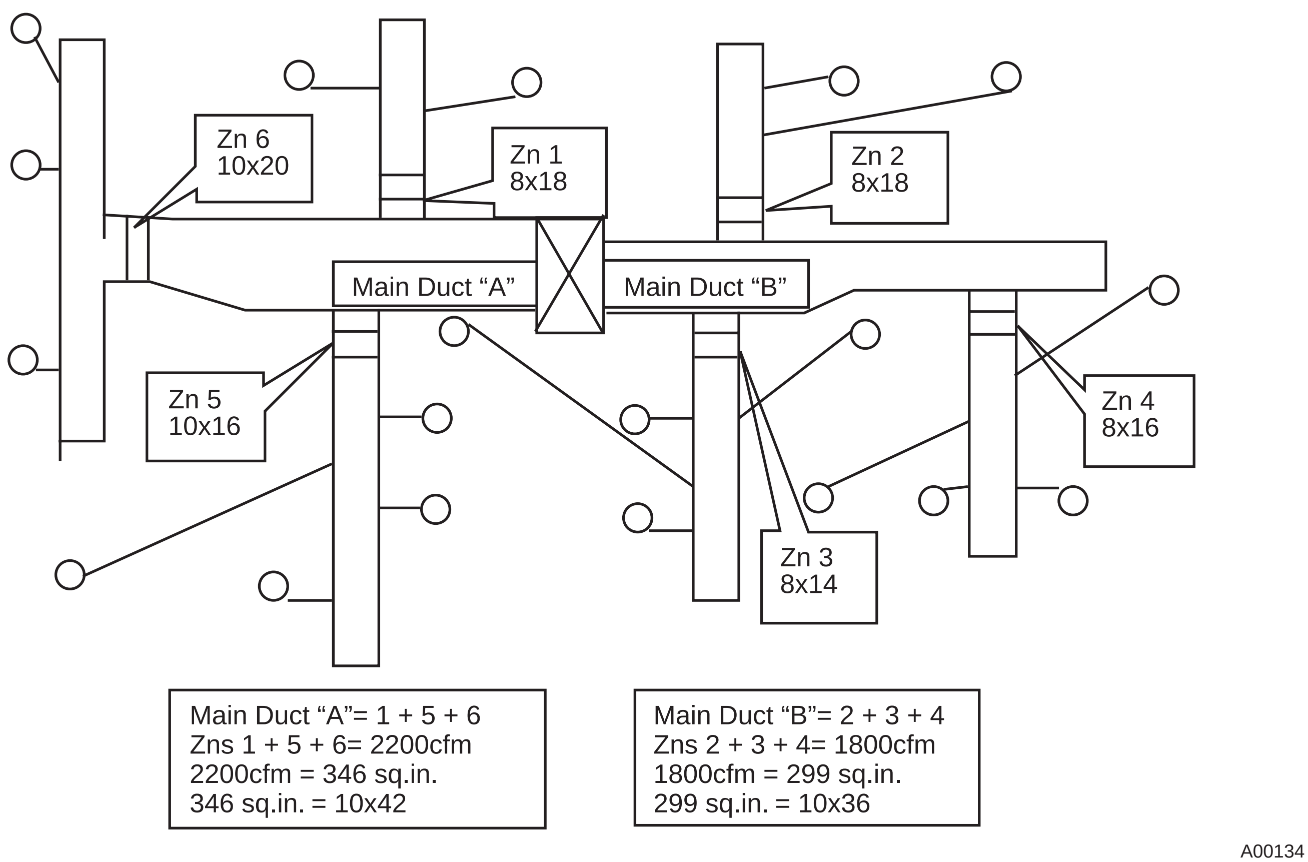

Fig. 6–Doctor’s Office Duct Work Layout

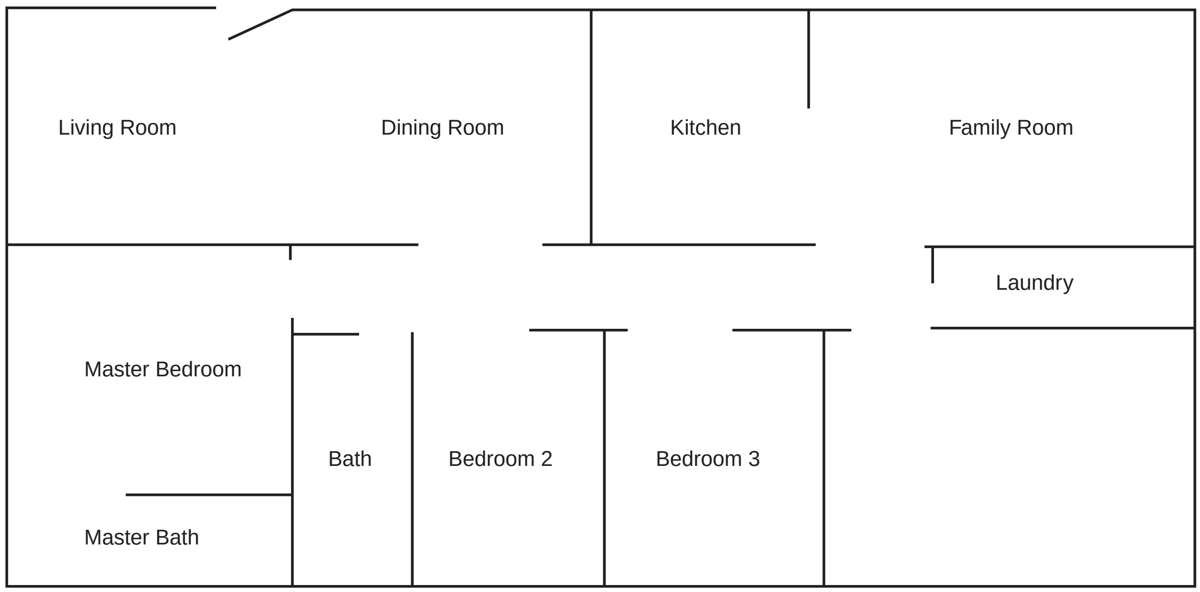

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Fig. 7–Residential Application-House Floor Plan (unzoned)

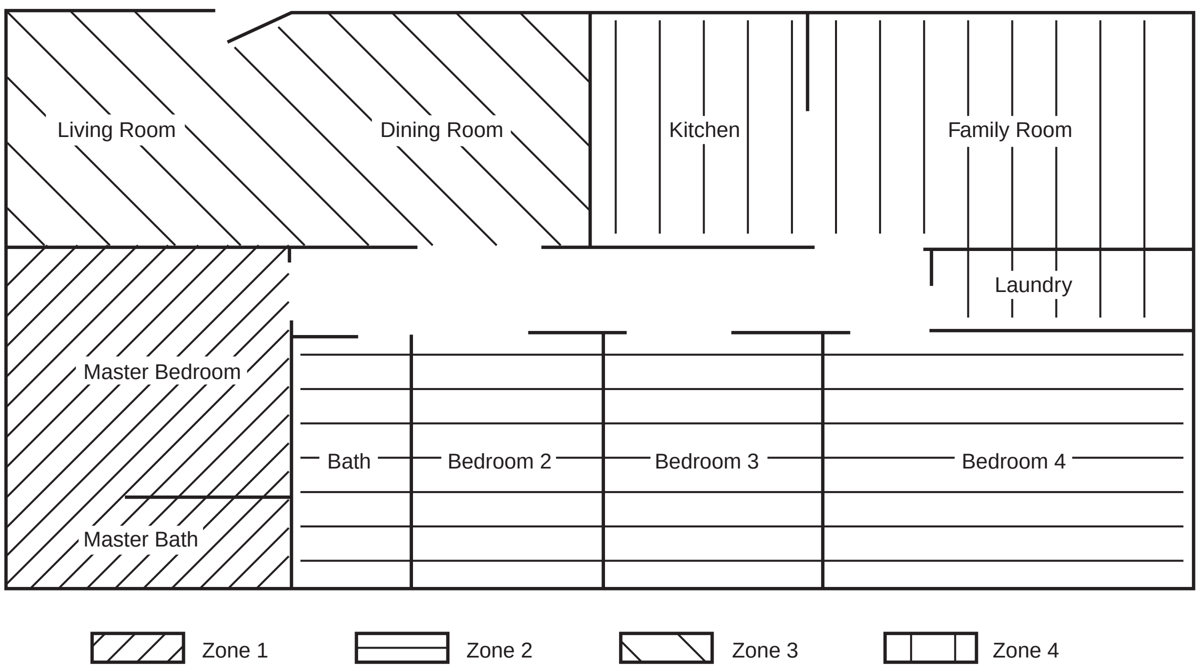

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Fig. 8–Residential Application-House Floor Plan (zoned into four areas)

DUCT SIZING WORKSHEET-EXAMPLE 2

Step 1:Calculate Block Load

Heating Load:__________90,000_____ Btuh

Cooling Load:_________52,000_____ Btuh

Step 2:Room by Room Load

Room	Heating Load (Btuh)	Cooling Load (Btuh)	Airflow (CFM)*	Zone Number
Living Room_			150	3
Dining Room/Foyer			150	3
Kitchen/Dinette			200	4
Family Room_			200	4
Laundry Room			300	4
Master Bedroom/Bathroom			400	1
Bedrooms 2-4/Bathroom			500	2

*Highest CFM determined from Heat/Cool Btuh

Step 3: Zone CFM totals

Zone 1 _____400____ CFM

Zone 2 _____500____ CFM

Zone 3 _____300____ CFM

Zone 4 _____700____ CFM

Zone 5 _____________CFM

Zone 6 _____________CFM

Zone 7 _____________CFM

Zone 8 _____________CFM

Step 4: Equipment Selection

	Indoor Section	Outdoor Section
Indoor Section / Outdoor Section	355MAV06100	598B060
Heating Capacity/CFM	95,000/62,000	1320/860
Cooling Capacity/CFM	53,000/34,000	2,000/1,200
Design CFM	1,200 (low speed A/C)	

Step 5: Bypass Determination

System Design CFM * ___1,200____ X 0.60 = _______720____

(Value MUST be less than smallest zone CFM; otherwise Bypass Damper may be required)

* Design CFM can be: Step 1C from above OR if Two Speed/Variable Speed equipment is selected, select low speed CFM value...used 2-speed A/C unit/low CFM=1200CFM

Step 6: Zone Minimum Area (Sq.In.) (From Table 1)

Zone 1 CFM__ 400____	Main Duct ___86___Sq.In.	Branch Area__132___Sq.In.
Zone 2 CFM__ 500____	Main Duct __113___Sq.In.	Branch Area__165___Sq.In.
Zone 3 CFM__ 300____	Main Duct ___87___Sq.In.	Branch Area__110___Sq.In.
Zone 4 CFM__ 700____	Main Duct __143___Sq.In.	Branch Area__231___Sq.In.
Zone 5 CFM_________	Main Duct________Sq.In.	Branch Area________Sq.In.
Zone 6 CFM_________	Main Duct________Sq.In.	Branch Area________Sq.In.
Zone 7 CFM _________	Main Duct________Sq.In.	Branch Area________Sq.In.
Zone 8 CFM _________	Main Duct ________Sq.In.	Branch Area________Sq.In.

Table 1
Zone CFM

Main Duct Area (sq.in.)
Equipment Capacity

Zone CFM		2	2.5	3	3.5	4	5	6	7.5	8
200	Main	57	57	57	64	64	64			
	Branch	66	66	66	75	75	75			
300	Main	79	79	79	79	79	87	87		
	Branch	99	99	99	99	99	110	110		
400	Main	86	86	86	86	86	86	104	104	104
	Branch	132	132	132	132	132	132	140	140	140
500	Main	113	113	113	113	113	113	113	123	123
	Branch	165	165	165	165	165	165	165	179	179
600	Main	123	123	123	123	123	123	123	123	133
	Branch	198	198	198	198	198	198	198	198	208
700	Main		143	143	143	143	143	143	143	143
	Branch		231	231	231	231	231	231	231	231

A00135

Step 7:Main Trunk (Table 2A) and Branch Duct (Table 2B) Sizes

Zone 1

Main Duct (sq. in.):__________________86 = Main Duct Size:________8x12

Branch (sq. in.):____________________132

Size:6″ Qty:__2 Area (from Table 2B) =_______________56+

Size:7″ Qty:__2 Area (from Table 2B) =_______________76+

=______________132 Total Sq. In.

Zone 2

Main Duct (sq. in.):_________________113 = Main Duct Size:________8x16

Branch (sq. in.):___________________165

Size:6″ Qty:__2 Area (from Table 2B) =_______________56+

Size:7″ Qty:__3 Area (from Table 2B) =______________114+

=______________165 Total Sq. In.

Zone 3

Main Duct (sq. in.):__________________87 = Main Duct Size:________8X12

Branch (sq. in.):____________________110

Size:7″ Qty:__3 Area (from Table 2B) =______________114+

Size:__ Qty:___ Area (from Table 2B) =_________________+

=______________114 Total Sq. In.

Zone 4

Main Duct Square Inches__143____ = Main Duct Size __8x20_____

Table 2A Main Duct Sizing

Equivalent Areas for Ducts (sq.in.)

Duct Width	Duct Height (in.) 8	10	Round Dia-Inch	Sq.In.
8	60	80	8	50
10	80	87	10	79
12	90	110	12	113
14	105	135	14	154
16	115	157	16	201
18	125	167		
20	145	190		
22	155	210		
24	165	215		

Branch Square Inches_____231__

Size__6"___Qty___2___ Area (from Table 2B)=___56___+

Size__8"___Qty___3___ Area (from Table 2B)=__180___+

=__236___Total Sq.In.

Table 2B Branch Duct Area (Sq.In)

Quantity	Duct Diameter - in. 5	6	7	8	10
1	20	28	38	60	79
2	40	56	76	135	180
3	60	84	114	180	330
4	80	112	152	235	465
5	100	140	190	300	530
6	120	168	228	365	660
7	140	196	266	430	760
8	160	224	304	500	825

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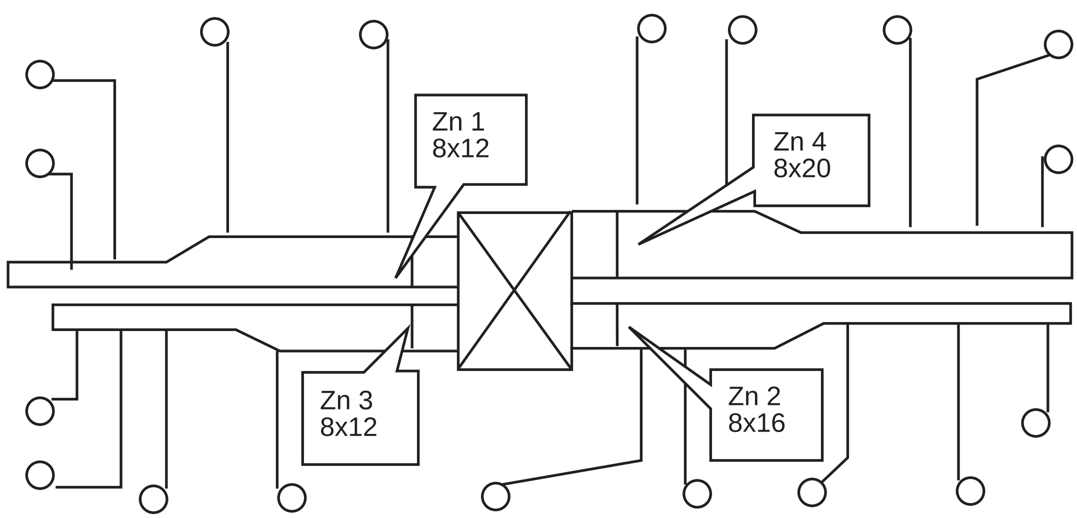

A00137

Fig. 9–Residential Duct Work Layout

DUCT SIZING WORKSHEET-EXAMPLE 3

Starting from Step 6, we need to multiply the Main Duct Square Inches by 1.1 and the Branch Area by 1.25.

Example: Zone 1 - Main Duct - 86x1.1 = 95 Sq.In.
Branch Area - 132x1.25 = 165 Sq.In.

Step 6: Zone Minimum Area (Sq.In.) (From Table 1)

Zone 1 CFM ___400____Main Duct ___95____Sq.In. Branch Area__165____Sq.In.
Zone 2 CFM ___500____Main Duct __124____Sq.In. Branch Area__206____Sq.In.
Zone 3 CFM ___300____Main Duct ___96____Sq.In. Branch Area__138____Sq.In.
Zone 4 CFM ___700____Main Duct __157____Sq.In. Branch Area__289____Sq.In.
Zone 5 CFM __________Main Duct _________Sq.In. Branch Area_________Sq.In.
Zone 6 CFM __________Main Duct _________Sq.In. Branch Area_________Sq.In.
Zone 7 CFM __________Main Duct _________Sq.In. Branch Area_________Sq.In.
Zone 8 CFM __________Main Duct _________Sq.In. Branch Area_________Sq.In.

Step 7: Main Trunk (Table 2A) and Branch Duct Size (Table 2B) Sizes

Zone 1

Main Duct Square Inches ___95____ Main Duct Size___8x14____

Table 2A Main Duct Sizing

Equivalent Areas for Ducts (sq.in.)

Duct Width	Duct Height (in.) 8	10	Round Dia-Inch	Sq.In.
8	60	80	8	50
10	80	87	10	79
12	90	110	12	113
14	105	135	14	154
16	115	157	16	201
18	125	167		

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Branch Square Inches_____165__

Table 2B Branch Duct Area (Sq.In)

	Duct Diameter - in.				
Quantity	5	6	7	8	10
1	20	28	38	60	79
2	40	56	76	135	180
3	60	84	114	180	330
4	80	112	152	235	465
5	100	140	190	300	530
6	120	168	228	365	660
7	140	196	266	430	760
8	160	224	304	500	825

Size_______Qty_______ Area (from Table 2B)=________+
Size__8"___Qty___3___ Area (from Table 2B)=__180___+
=__180___Total Sq.In.

Zone 2

Main Duct Square Inches___124____ =Main Duct Size ___8x18___
Branch Square Inches ___206____
Size_______Qty_______ Area (from Table 2B)=________+
Size__8"___Qty___4___ Area (from Table 2B)=__235___+
=__235___Total Sq.In.

Zone 3

Main Duct Square Inches___96____ =Main Duct Size ___8x14___
Branch Square Inches ___138____
Size_______Qty_______ Area (from Table 2B)=________+
Size__7"___Qty___4___ Area (from Table 2B)=__152___+
=__152___Total Sq.In.

Zone 4

Main Duct Square Inches___157____ =Main Duct Size ___8x24___
Branch Square Inches ___289____
Size__8"___Qty___5___ Area (from Table 2B)=__300___+
Size_______Qty_______ Area (from Table 2B)=________+
=__300___Total Sq.In.

A00139

TABLE 1–ZONE CFM

		MAIN & BRANCH DUCT AREA (SQ. IN.)											
		Equipment Capacity											
		2	2.5	3	3.5	4	5	6	7.5	8	8.5	10	12.5
200	Main	57**	57	57	64	64	64						
	Branch	66***	66	66	75	75	75						
300	Main	79	79	79	79	79	87	87					
	Branch	99	99	99	99	99	110	110					
400	Main	86	86	86	86	86	86	104	104	104			
	Branch	132	132	132	132	132	132	140	140	140			
500	Main	113	113	113	113	113	113	113	123	123	123	123	
	Branch	165	165	165	165	165	165	165	179	179	179	179	
600	Main	123	123	123	123	123	123	123	123	133	133	133	133
	Branch	198	198	198	198	198	198	198	198	208	208	208	208
700	Main		143	143	143	143	143	143	143	143	154	154	154
	Branch		231	231	231	231	231	231	231	231	246	246	246
800	Main		154	154	154	154	154	154	154	154	154	154	165
	Branch		264	264	264	264	264	264	264	264	264	264	273
900	Main			165	165	165	165	165	165	165	165	165	177
	Branch			297	297	297	297	297	297	297	297	297	311
1000	Main			189	189	189	189	189	189	189	189	189	201
	Branch			330	330	330	330	330	330	330	330	330	330
1100	Main				201	201	201	201	201	201	201	201	201
	Branch				363	363	363	363	363	363	363	363	363
1200	Main				214	214	214	214	214	214	214	214	214
	Branch				396	396	396	396	396	396	396	396	396
1300	Main					227	227	227	227	227	227	227	227
	Branch					429	429	429	429	429	429	429	429
1400	Main					241	241	241	241	241	241	241	241
	Branch					462	462	462	462	462	462	462	462
1500	Main						254	254	254	254	254	254	254
	Branch						495	495	495	495	495	495	495
1600	Main						269	269	269	269	269	269	269
	Branch						528	528	528	528	528	528	528
1700	Main							284	284	284	284	284	284
	Branch							561	561	561	561	561	561
1800	Main							299	299	299	299	299	299
	Branch							594	594	594	594	594	594
1900	Main								314	314	314	314	314
	Branch								627	627	627	627	627
2000	Main								314	314	314	314	314
	Branch								660	660	660	660	660
2100	Main									330	330	330	330
	Branch									693	693	693	693
2200	Main									346	346	346	346
	Branch									726	726	726	726
2300	Main											363	363
	Branch											759	759
2400	Main											363	363
	Branch											792	792
2500	Main											380	380
	Branch											825	825

Shaded areas represent less than 20 percent of total CFM, increased by one size.

*Main Duct sq in. are determined by multiplying CFM by 1.3 (200x1.3=260). Then size duct based on square inches of round pipe. Example: 260CFM.1 in. wc = 8.5” round pipe = 57 sq in.

**Branch duct sq in. are based on 6” pipe delivering 100 CFM .1 in. wc X 1.3 = 130 CFM. Take 130 CFM .1 in. wc =6.5”pipe = 33 sq in. Example: 33 sq in. /100 CFM X 2 = 66 CFM

TABLE 2A-MAIN DUCT SIZING

EQUIVALENT AREAS FOR DUCTS (SQ. IN.)					
	Duct Height			Round	
Duct Width	8(in.)	10(in.)		Dia-in.	Sq-in.
8	60	80		8	50
10	80	87		10	79
12	90	110		12	113
14	105	135		14	154
16	115	157		16	201
18	125	167		18	269
20	145	190		20	314
22	155	210		22	380
24	165	215			
26		227			
28		241			
30		254			
32		269			
34		284			
36		299			
38		314			
40		330			
42		346			
44		363			

TABLE 2B-BRANCH DUCT AREA (SQ. IN.)

	DUCT DIAMETER - IN.							
Quantity	5	6	7	8	10	12	14	16
1	20	28	38	50	79	113	154	201
2	40	56	76	135*	180	365	565	760
3	60	84	114	180	330	530	795	825
4	80	112	152	235	465	730	825	
5	100	140	190	300	530	825		
6	120	168	228	365	660			
7	140	196	266	430	760			
8	160	224	304	500	825			
9	180	252	342	565				
10	200	280	380	630				
11	220	308	418	660				
12	240	336	456	726				
13	260	364	494	795				
14	280	392	532					
15	300	420	570					

Two 8” pipes have approximately the same volume of five 6” pipes. To keep static approximately .1 in. wc, the numbers were adjusted to handle same CFM .1 in. wc.

Example:
6” pipe = 100 CFM .1 in. wc X 5 = 500 CFM
8” pipe = 240 CFM .1 in. wc X 2 = 480 CFM.

Square inches adjusted to match sizes with Table 1 — Branch values.