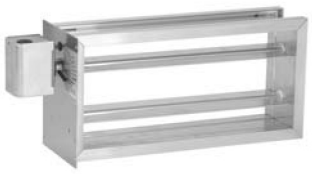
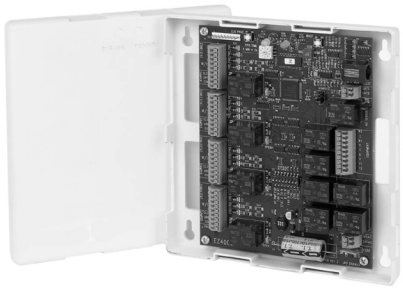




ZONING SYSTEM DESIGN

Zoning any forced air system is easy once you know a few of the basic rules. The main consideration is to maintain a constant amount of air flow (CFM) through the HVAC Unit. This needs to occur when only one zone is open and if the zones are of varying size when the smallest zone is open. The other consideration is not to oversize a duct system too much in order to maintain adequate velocity and airflow when all zones are open and may be calling for conditioning on those design temperature days.

The design of the duct system for today's zoning is an important factor to a comfortable and efficient zoning system. The number of zones, along with their size, often determine the best type of design.

There are scenarios for zoning. The first, which is typically on new installations where the duct work can be designed for zoning would be to oversize the ducts for each zone in order to get more air to the zone when it may be the only one calling. The scenario for all others would be to use a by-pass damper to relieve the excess air pressure in the duct system when a minority number of zones are calling.

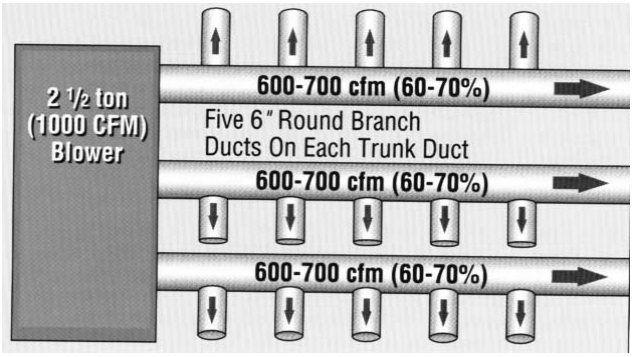
The reason for each zone duct being the same size is that any zone could be the only zone calling and therefore that zone must handle the CFM of the HVAC Unit. When the duct is sized for 2/3 of the total CFM the smaller size does restrict the airflow and forces the air at a higher pressure and velocity, however it does not increase the air typically over that static pressure rating of the blower motor, usually 0.5"W.C. This also keeps the air velocity from being noticeably noisy. Below is a quick guide to determine the minimum equivalent size of a zone duct for each size HVAC Unit.

System CFM	Zone Trunk Duct Size	Branch Ducts
800 CFM	12 × 8 or 12" Round	5 - 6" Rounds
1,000 CFM	14 × 8 or 12" Round	5 - 6" Rounds
1,200 CFM	16 × 8 or 12" Round	6 - 6" Rounds
1,400 CFM	18 × 8 or 14" Round	5 - 7" Rounds
1,600 CFM	20 × 8 or 14" Round	5 - 7" Rounds
2,000 CFM	22 × 8 or 16" Round	5 - 8" Rounds

Systems over 5 Tons typically are commercial and would use a by-pass damper to relieve the excess air pressure when the majority of zones shut down.

In retrofit and systems with 4 zones or more, over sizing the ducts is not practical. In these instances a by-pass damper is used to relieve the excess air back into the return air duct or dump the air into a central area of the building, such as a hallway, where often there is a common return. In this instance try to locate the by-pass air as far away from the return air intake as possible.

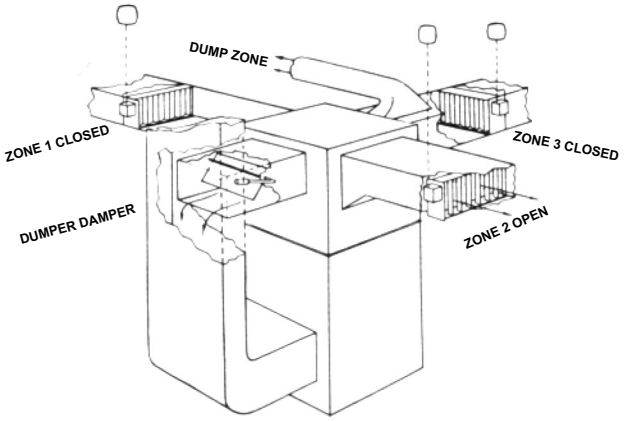
In new installations where ducts are being added it is recommended to size each zone duct the same and to size the duct for approximately 2/3 of the total HVAC System CFM. This is practical on systems with 2 or 3 zones and when all zones are approximately equal in size. This is NOT practical in an installation where 80% of conditioned area is one zone and 20% is the other zone.



The key to a good zoning system is to deliver the conditioned air to the calling zone as fast and quietly as possible in order to satisfy the demand. Whatever air cannot be directed into the zone must then by by-passed. This develops the formula for calculating the size of the by-pass damper.

Total CFM - **S**mallest Zone CFM = **B**y-Pass CFM

Once the amount of by-pass air is known it is just common sense to size a duct adequately to handle the amount of air. White-Rodgers has both round and rectangular/square by-pass damper sizes.



The diagram above shows a typical three zone damper system with a barometric by-pass, Model CSPRD, between the supply air and return air duct. A round take-off is also shown as an uncontrolled dump zone delivering air continuously to a non-critical temperature area, such as a basement or hallway as another method of relieving excess air. Either a by-pass or a dump zone is used but rarely ever is there a need for both.

MINIMUM POSITION DAMPER

Another form of by-pass is using minimum position dampers, such as the CZD and CRDS dampers. Setting the larger zone dampers to a minimum position can also be a method of relieving excess air pressure. This should be used when only small amounts of air need to be by-passed as the minimum position air in some cases can cause a zone to overshoot its comfort zone. Caution must be exercised when using minimum position dampers for by-pass.

ZONING HEAT PUMPS

Heat Pumps are a very popular form of heating and cooling in the milder climates of the country. These efficient units use the compressor for both heating and cooling and have a reversing valve that reverse the flow of refrigerant in order to switch between heating and cooling modes.

Heat pumps, while very efficient, are also most efficient in milder climates where often there is more of a cooling demand than a heating demand, such as the southern United States. A heat pump is also rated based upon its cooling capacity and not the heating capacity and rely typically on electric resistance heating to supplement the heat pump in colder weather, often less than 35°F to 40°F. When this back-up form of heat is used to supplement the heat pump compressor, the cost to heat the home rises dramatically. It is this reason that zoning should be installed with every heat pump.

Heat pumps with their limited capacity for heating cannot afford to be run on the colder climates heating the entire home or building. However if the heat pump is zoned, most likely less than the total building requires heat at any one time. The zone calling typically requires less than the total BTU capacity of the heat pump, more evenly matching the heat pumps capacity to the load of the calling zone. By doing so this lessens the need for the supplemental heat to come on, therefore providing substantial energy savings.

For example, a typical home may have a 3 Ton (36,000 BTU) heat pump. The total heating load for the home at heating design temperature maybe 60,000 BTUs or even more. Obviously with only 36,000 BTUs the heat pump can never keep up at design temperatures. However during milder temperature days, those above 45°F, the heat pump will often be more than adequate.

Heat pumps most efficient outdoor temperature, typically 45°F to 50°F and the amount of BTUs produced by the heat pump decreases as the temperature moves further below this temperature. This is when the supplemental electric resistance heat is often needed. As the heat pump compressor heats the air, the electric resistance heaters, located downstream of the heat pump coil, can come on to supplement the heat pump air. However if the system is zoned and heating is required for typically only one room or zone, the capacity of the heat maybe equal to or greater than the heating load of that zone and even as the output of the heat pump diminishes as the outdoor temperature falls, the capacity of the heat pump, (BTU output) is adequate for the zone(s) calling therefore not requiring the use of the supplemental heating.

The combined use of zoning and heat pumps allows more equally matched capacity to match the load of those zones calling allowing the most efficient form of heating to be used. Even during the colder times when the supplemental electric heat is needed, it is important to remember that a smaller amount of heating is always required for one room or zone vs. the whole house. Zoning allows the heating to be directed only to those areas needing it.

FOSSIL FUEL FURNACES AND ADD-ON HEAT PUMPS

When a heat pump is added on to a fossil fuel (gas or oil) furnace, the sequence of operation is somewhat different than using electric resistance heating as supplemental heating. The heat pump coil is often on the supply side of the furnace and both the heat pump and furnace cannot be run together as the high temperature from the furnace will cause the heat pump compressor safeties to engage.

All heat pump manufacturers use a fossil fuel kit in order to make the most effective use of the heat pump and furnace. Simply this fossil fuel kit uses an outdoor thermostat to switch between the heat pump and furnace based upon the outdoor temperature or balance point. The balance point is calculated to determine the most effective temperature to operate the heat pump vs. the furnace. See the heat pump manufacturer's information to calculate the balance point.

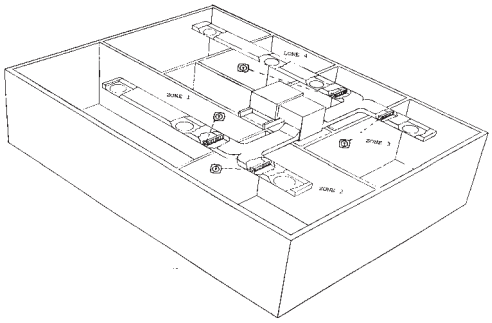
When using a White-Rodgers System with an add-on heat pump it is recommended to use the manufacturer's fossil fuel kit in order maintain the manufacturer's warranty. The zone control panel equipment terminal block will be wired to the thermostat connections on the fossil fuel kit.

When using any heat pump it is important to remember that with a limited amount of heating capacity, ZONING is imperative in order to make maximum use of the heat pump and where the individual zone load is more closely matched to the capacity of the heat pump.

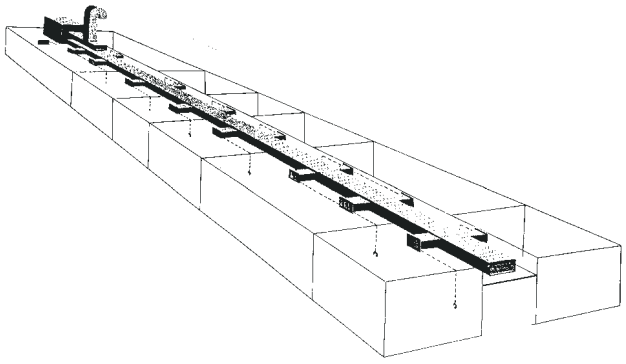
ZONING COMMERCIAL SYSTEMS

Zoning for commercial and light commercial office buildings makes even more sense as every person has their own idea of their own comfort level. The number 1 and 2 complaints in any office is its either TOO HOT or its TOO COLD. Being able to provide each office with its own thermostat to control the temperature is a simple and cost effective way to solve this problem.

Here is a small professional office with 4 zones. One zone would be the waiting room, reception area, another be the receptionist's office, another be the boss's/doctor's office, or conference room and the other smaller rooms be offices or examining rooms all on the same zone.



In commercial buildings the need for zoning is increased by the building exposure when offices facing south and north are controlled by the same thermostats. Those south facing offices on a bright sunny day may be needing cooling while offices on the northern side with no solar gain still need heating. In the morning the entire building may need heating for a morning warm up and soon after only the perimeter offices need heating while the interior core needs cooling. Conference rooms that go for hours unused can be shut off and then when there is a meeting and the offices are not being used, the conference room can be controlled comfortably by having its own thermostat.



White-Rodgers Systems can automatically direct the flow of the conditioned air to those zones needing it and automatically switch over and provide the opposite mode to the other zones eliminating the need for on site techs to constant balance and adjust outlets based upon the ever changing conditions.

Light Commercial and Commercial systems are basically just bigger residential systems with more capacity. Duct design for these will almost always include a by-pass system, especially those over two to three zones. The commercial systems are easier to retrofit as the false ceiling space if often used as a common return and a great place to by-pass the air. Wiring is a snap as well as damper installation all taking place in the false ceiling.

Zoning also helps the landlord in tenant improvement costs by eliminating the need to ad separate air conditioning units in order to satisfy multiple tenants on one HVAC system. While one tenant in a professional suite maybe an attorney and have more normal working hours, the doctor and dentist with after hours patients on evenings and Saturdays can still get conditioning by having there own temperature control.

Commercially, zoning is a very economical alternative to the more sophisticated VAV and computer controlled HVAC systems. Zone Control in commercial buildings can range from installing a single motorized damper and thermostat to control an over-conditioned or seldom used room or office; such as a conference/training room to zoning every room on the HVAC System.

There is really little difference in zoning a residential 5 Ton Split HVAC System and a commercial 5, 7-1/2, 10, 15 or 20 Ton Package Rooftop HVAC Unit. The system components of the dampers, thermostats and control panel can be the same in many instances. The only difference is the commercial rooftop maybe 2 stage heating and/or cooling and there may be more zones and the duct sizes may be larger, however the basic operation remains the same.

The Number 1 and 2 complaints in office buildings are people are either Too HOT…..or Too COLD. Zoning is the less expensive alternative to the more commercially used VAV Systems and provides just as good temperature control as those expensive system for a fraction of the cost.

The design of a commercial zoning is also the same as a residential system where a by-pass is most typically used. Small commercial systems that may be just two zones might be able to get away without a by-pass provided they are only two zones and the ducts for each zone are large enough to handle 60% to 70% of the total airflow.

Commercial zoning systems of three zones or more will need a by-pass. The by-pass for commercial is often easier as many times the false ceiling space is used as a common return. Here again it is always important for the by-pass damper to be located as far away from the blower as possible. Barometric by-pass dampers can be used up to 7.5 Tons (3,000CFM). Over 10 Tons (4,000 CFM) should use a motorized by-pass and a static pressure control.

ZONING versus MULTIPLE UNITS

For years many HVAC Installers and Home Builders have used multiple HVAC units in order to accomplish zoning. Installing a unit for the upstairs and another for the downstairs is typically most common. While effective to achieve zoning, using multiple units is often an unnecessary and substantially higher added cost.

There are good reasons for using multiple units. They would be that the load of the home is so big that multiple units are needed. Homes continue to grow in size and on average homes over 3,000 square feet will typically require more than 5 Tons of cooling. In these larger homes, multiple units are necessary. Typically trying to use one central unit also creates long duct runs that may not properly get the airflow to all areas. Using multiple smaller units can be more effective however in these instances a zoning system should still be looked at as each smaller unit could still be subdivided into small zones.

The case for multiple units is also used in existing homes where add-on air conditioning may be installed and duct work cannot be run throughout the house. Example a older home without ductwork, that may utilize steam or hot water heating and air conditioning is being added. In order to add central air conditioning for both levels ductwork cannot be run from the basement to the second floor or from the attic down to the first floor.

However when two units are installed side by side in the same area and both units add up to less than 6 Tons, this is the case for using one unit and zoning.

Anytime a contractor can install one unit versus two, or more, the homeowner wins. Maintenance costs are cut with every unit saved. Remember the maintenance of air filters, electronic air cleaners, humidifiers, electrical requirements and the life expectancy of these HVAC units as well, are unnecessary added costs that can be saved by using one unit and zoning.

Another reason for using one larger unit with zoning is to economically obtain zoning and the highest efficiency HVAC equipment. Often when multiple HVAC units are installed these units are typically on the lower scale of efficiency. For heating this is an 80% efficient furnace. For cooling this is a 10 SEER air conditioning unit.

ZONING EFFICIENCY AND DOWNSIZING

The standard way of not living in your whole house all of the time and mostly occupying one zone of the home at a time proves the need for zoning. Zoning makes the use of the heating and cooling more effective by only conditioning those zones being occupied or that may need it. Therefore typically the majority of the time, even on a two zone system only one zone is typically calling.

When this occurs the furnace and air conditioner is oversized in BTU capacity when supplying only a single zone. Due to this many HVAC Installers will downsize the heating and/or cooling units based upon the use of zoning. On a two zone system this many not be recommended, however when using 3 or more zones it is practical to downsize to the next lower capacity unit.

An HVAC Unit should be sized to heat and cool the home at design temperatures (the hottest days in summer and the coldest days in winter). Realistically how often do design conditions occur. Of course this depends upon where you live. In the milder climates downsizing is much more of a possibility than in the severe heating climates of Northern states or the southern cooling climates.

HVAC installers have been quite successful in going to the next smaller size unit when using zoning. In many cases heating and cooling units are often oversized, especially on older homes. Doing a heat loss and heat gain calculation is very important in determining the size of the heating and cooling unit. Once the loads are determined for the overall structure, the affect that zoning will have on the overall load can be determined. Seldom used zones such as basements or extra bedroom loads can be looked at as not always needing conditioning at the same time as more often used zones. In instances where 3 or more zones are used may be advantageous to downsize to the next smaller size of heating and cooling unit.

NOTE: There are times during extended periods at design temperatures where it will take longer for the zones to satisfy as the heating or cooling. It is important to note that some zones would have to be adjusted in order to direct more BTUs to the more important zones.

Down sizing while also increasing efficiency is often the best way to go. When considering the alternative of using 2 separate lower efficiency units in order to zone vs. one high efficiency unit with zone damper system, the cost difference is negligible if not sometimes less. Take for example the following scenario and price out the costs comparison of the following example.

A 100,000BTU Home with 2 Zones.

Two Units @ 80% Efficiency 2Units	vs.	One Zoned 90% Efficiency 1 Unit
x 50,000 BTU Each (100,000 Total)		x 90,000 BTU (Downsized)
x .8 (80% Efficiency)		x .9 (90% Efficiency)
= 80,000BTU	vs.	= 81,000BTU

When you look at the two options you can still get more output, with higher efficiency and still provide zoning. Combine this with the potential utility rebates for the higher efficiency and that often offsets the added cost of the zoning system. Even going to one 80,000BTU, 90% efficiency unit will only decrease the total output by 10% . In milder climates this can be an approach to lower HVAC installed costs when quoting against the competition with 2 lower efficiency units.

Applying higher efficiency and zoning to cooling can also increase the effectiveness of the cooling. Here again if utility rebates are offered for the higher efficiency this can further offset the added cost of zoning and possibly add other comfort options.

Typically the more zones you have the wider the diversity in the use of the zones. This factor can help in downsizing the unit. Take for example an exercise room that may only be used a hour or two a day. The family recreation room that is only used for a few hours in the evening and not when all are sleeping in the bedrooms or eating in the kitchen dining room zones.

Zoning and high efficiency equipment can increase the overall energy performance of your home and keep rising energy costs down to manageable level.