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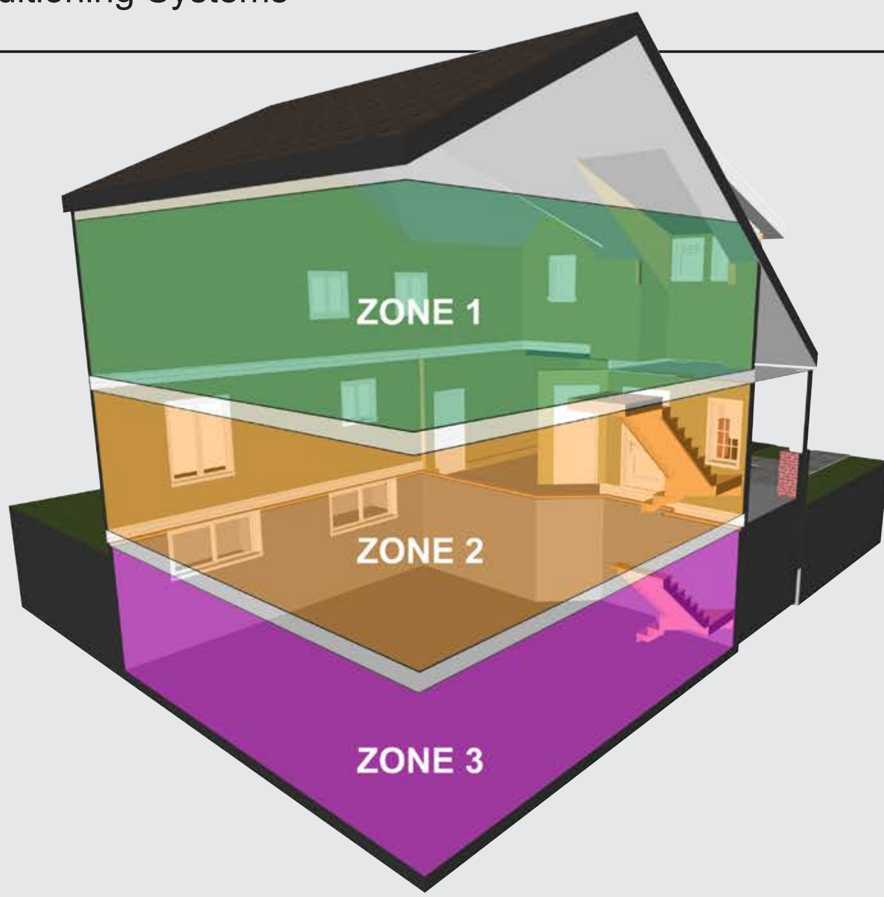
ZONING DECISION GUIDE FOR BUILDERS

Defining Key Features Required in Zoned Forced-Air Heating and Air Conditioning Systems



Developed by the Innovation and Energy Technology Sector's LEEP (Local Energy Efficiency Partnerships) team and CanmetENERGY housing researchers.

Canada

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INTRODUCTION

The Opportunity

Zoned forced air technology is being used to improve comfort and reduce energy consumption in tract housing. New technology options have brought down the base price so that forced air zoning is being used in tract singles and townhome developments such as those shown in Figure 1.

The Issue

Feedback from builder-group sessions at a Local Energy Efficiency Partnerships (LEEP) Initiative in Ottawa proved that builders want to use forced-air zoning and are ready to take action to get zoned systems installed. The issue for builders is specifying the types of centrally zoned systems they require, from the many options available, in order to capture the benefits identified in the LEEP sessions. The specific equipment, controls and duct-system selection decisions can lead to significant differences in system cost and efficiency, as well as complexity of installation, saleable benefits, comfort benefits and quality assurance requirements.

Builders need a way to communicate what they want, in order to get solutions which will satisfy their specific needs. Designers need a way to quickly review design options with builders so they can move forward with zoning designs. The **Zoning Decision Guide** has been designed to fill this information gap.

Figure 1: Examples of housing developments using zoned systems

Purpose of guide

The **Zoning Decision Guide** is intended for use by builders and their mechanical designers to define, communicate, discuss and finalize design details of zoned heating and cooling systems as illustrated in Figure 2.

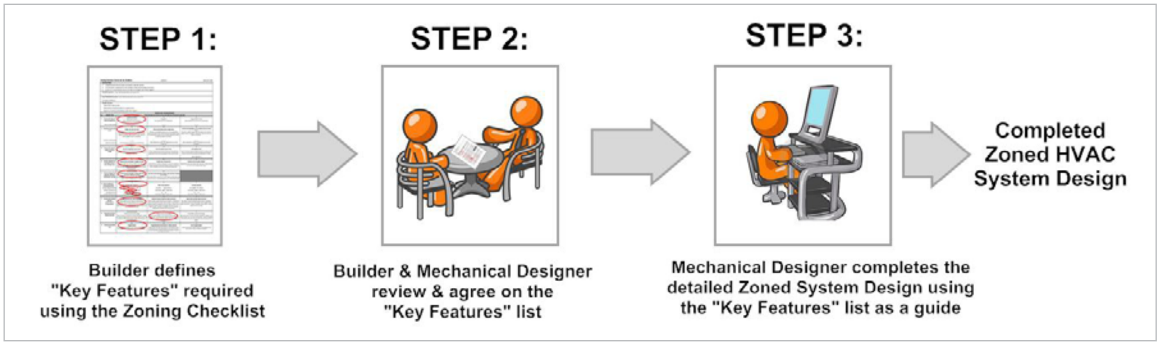


Figure 2: Collaborative decision making by builders & mechanical designers produce superior zoned-system designs

The Guide focuses on high-level technology decisions so that builders are better equipped to discuss specific zoning options with their mechanical designers, and it enables builders and designers to quickly consider a full range of zoning product options together.

The Guide consists of a two-page **Zoning Checklist** with seven decision points which are designed to be completed in order. This is followed by supporting information on each decision point to help with selecting the most appropriate zoning options for a given house model.

There are three suggested process steps for developing a new zoned mechanical system design.

STEP 1: Builders may want to initially complete the **Zoning Checklist** on their own to identify “key design features” before consulting with their mechanical designer.

STEP 2: Once the Builder has defined the “key design features” required in the zoned system, it is time to meet with their mechanical designer to get advice, and review and finalize the **Zoning Checklist** together. The mechanical designer needs to confirm the “key design features” decisions before the detailed mechanical-system design begins.

STEP 3: As the actual zoned system design is developed, some decisions may require further adjustment. The mechanical designer should notify the builder of these changes and discuss possible implications concerning equipment cost, system installation, comfort and energy efficiency.

Builders and designers can use these steps to obtain a zoned system design which will be economical to install; provide superior heating and cooling performance to all areas of the house; and, provide homeowners with new ways of managing energy usage.

Scope of the guide

There are many excellent ways to zone homes. The **Zoning Decision Guide** focusses only on centrally zoned forced air systems where the zoning dampers are provided within or installed close to the heating equipment.

TECHNICAL CONTEXT

Why zoning is being used to address the changing needs of today's housing

The housing products being delivered by tract builders have evolved, with today's design trends more often including:

- Open-concept homes that are more challenging to heat and cool evenly;
- Smaller footprint homes with a larger number of finished floors where homeowners expect similar comfort levels on each floor; and,
- Larger and more concentrated window areas on the front and back of narrow homes that increase heating and cooling loads in localized sections of the home.

In these types of house designs, heating and cooling systems controlled by a single thermostat located in the middle of the house can be challenged to maintain consistent comfort on the upper and lower floors. Stack effect increases in taller homes with differences in air-density causing hot air to pool at the top of the house and cooler air to pool at the bottom. This causes challenges in both heating and cooling seasons. Open concept homes make it easier for cool air to drop to the bottom of the home, and can make it more difficult to find wall space in which to run the ductwork required to get the right fraction of the supply air to upper floors. To address these challenges, some builders are starting to use zoning to deliver conditioned air to where it is needed.

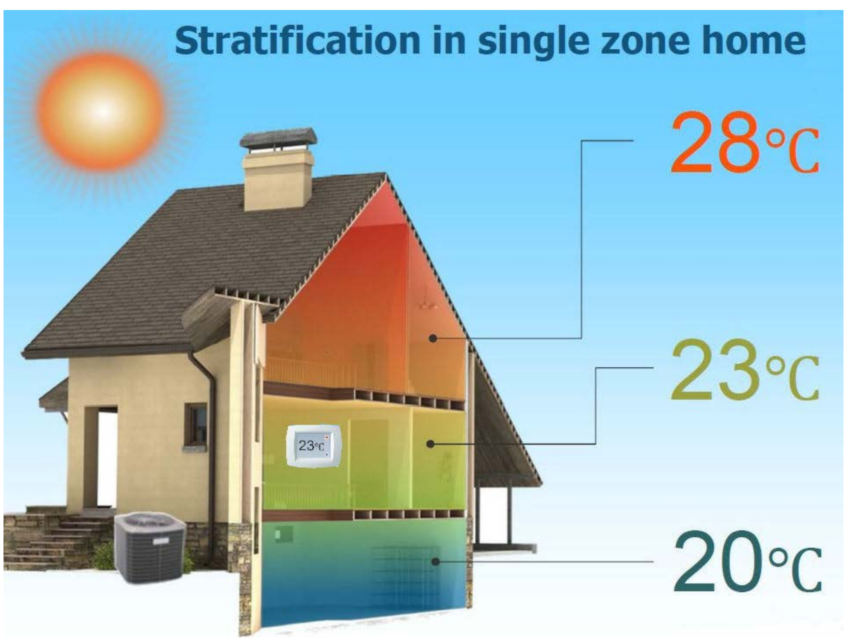


Figure 3: Temperature stratification creates comfort issues and is common in multi-storey house designs

Zoning for improved comfort and energy management

In field evaluations of fully zoned homes[1], 90% of participants responded that the fully zoned systems increased comfort with respect to temperature and 70% indicated that fully zoned systems reduced energy consumption.

The impact of zoning on energy usage

With single-zone systems, it is hard for homeowners to save on energy consumption by reducing heating and cooling in unoccupied areas of the home. Builders are using zoning to enable homeowners to reduce conditioning energy usage in unoccupied areas, while simultaneously maintaining comfort conditions in occupied areas of the home.

With forced-air zoning, occupants can choose to use their systems differently, which can have a significant impact on energy usage. CanmetENERGY and its industry partners conducted a 20-home field study that compared the energy usage for air conditioning in zoned homes to that of a control group of similar single-zoned homes. The zoned homes used "cooling setback" in the upper zone during the afternoon, while maintaining normal temperatures in the other zones. This control strategy reduced the afternoon, peak-period cooling demand for electricity in zoned homes to about half of that of the single-zoned homes as shown in Figure 4. However this change in control strategy did not negatively impact overnight comfort in the upper zone. Temperature and humidity measurements showed superior overnight comfort conditions in the zoned homes as compared to the single-zoned homes.

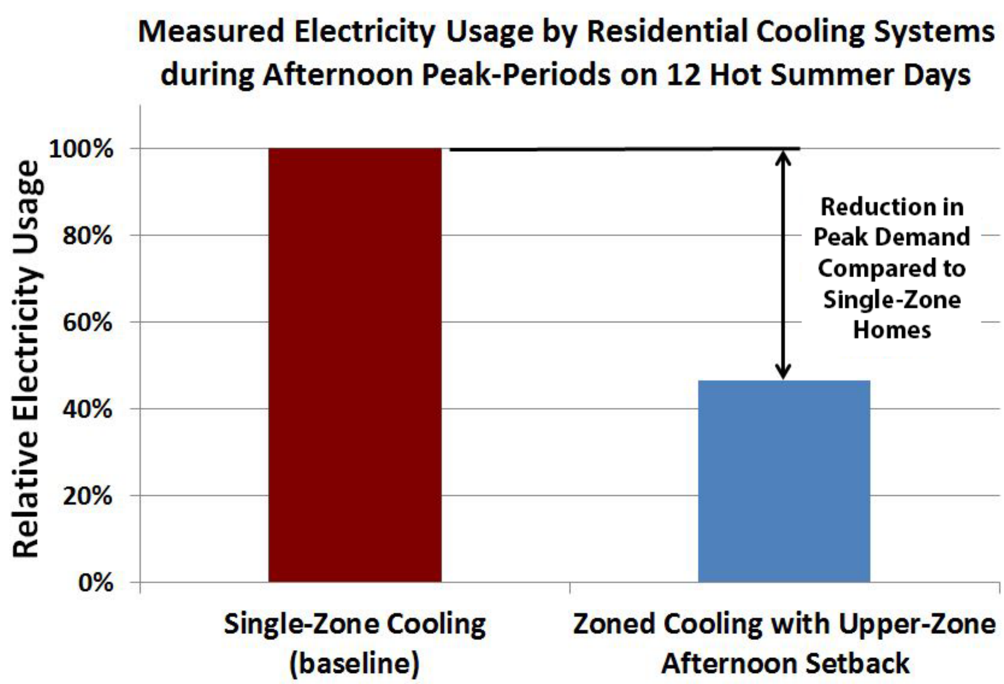


Figure 4: Zoning can reduce cooling system energy usage and provide new opportunities for peak-period electricity demand reduction

[1] Field trials were conducted by McMaster University during November 2009 to March 2011 involving two-storey and three-storey houses with zoned forced-air systems located in Southern Ontario.

Recent advances are making zoning more effective and more affordable

Historically, zoned systems have been most commonly applied in large custom homes, using multiple systems or other “site-assembled” zoning technologies consisting of numerous components, which must be individually installed and connected together. To reduce the time and expertise required to install and commission zoning, some equipment manufacturers have introduced “factory-integrated” zoning solutions which have all the zoning dampers and airflow controls in a single box. Electronically commutated motors (ECM) on blowers have made it much easier to vary air flow. Modulating equipment has made it easier to supply only the zone that has a need without the need for a bypass damper. Some tract builders have begun installing “factory-integrated” zoned systems in their townhome and other higher density projects. These builders have found that changes in the way zoning equipment is being offered can reduce equipment and installation costs to the point that zoning is now part of the base equipment package installed throughout the housing development.

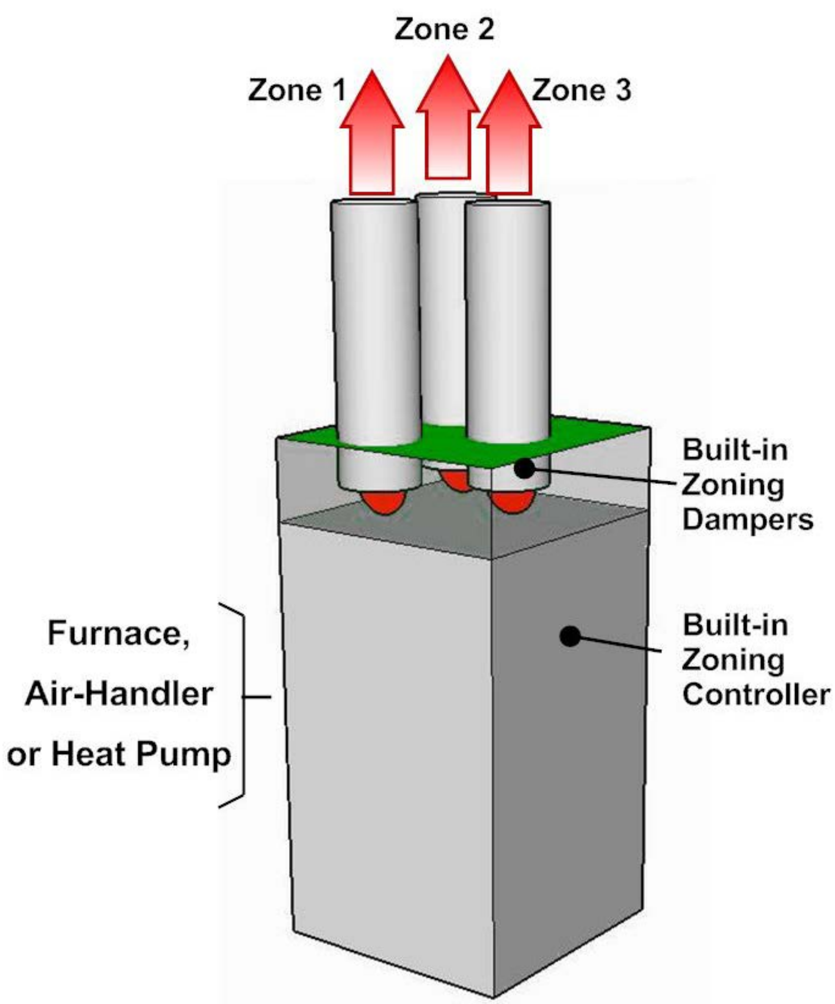


Figure 5: Example of a factory-integrated zoned Installation

Zoned duct systems can be accomplished with minimal changes from current practice

current practice to duct design can be used to design zoned duct systems that will work well with zoned HVAC equipment and traditional single zoned HVAC equipment. The most simplified approach to zoned duct design uses standard locations for supply-air outlets and return-air inlets and specifies common duct fabrication practices. The main change in the zoned duct design approach is that the supply trunk needs to be split and sized with one separate supply trunk for each zone as shown in Figure 6.

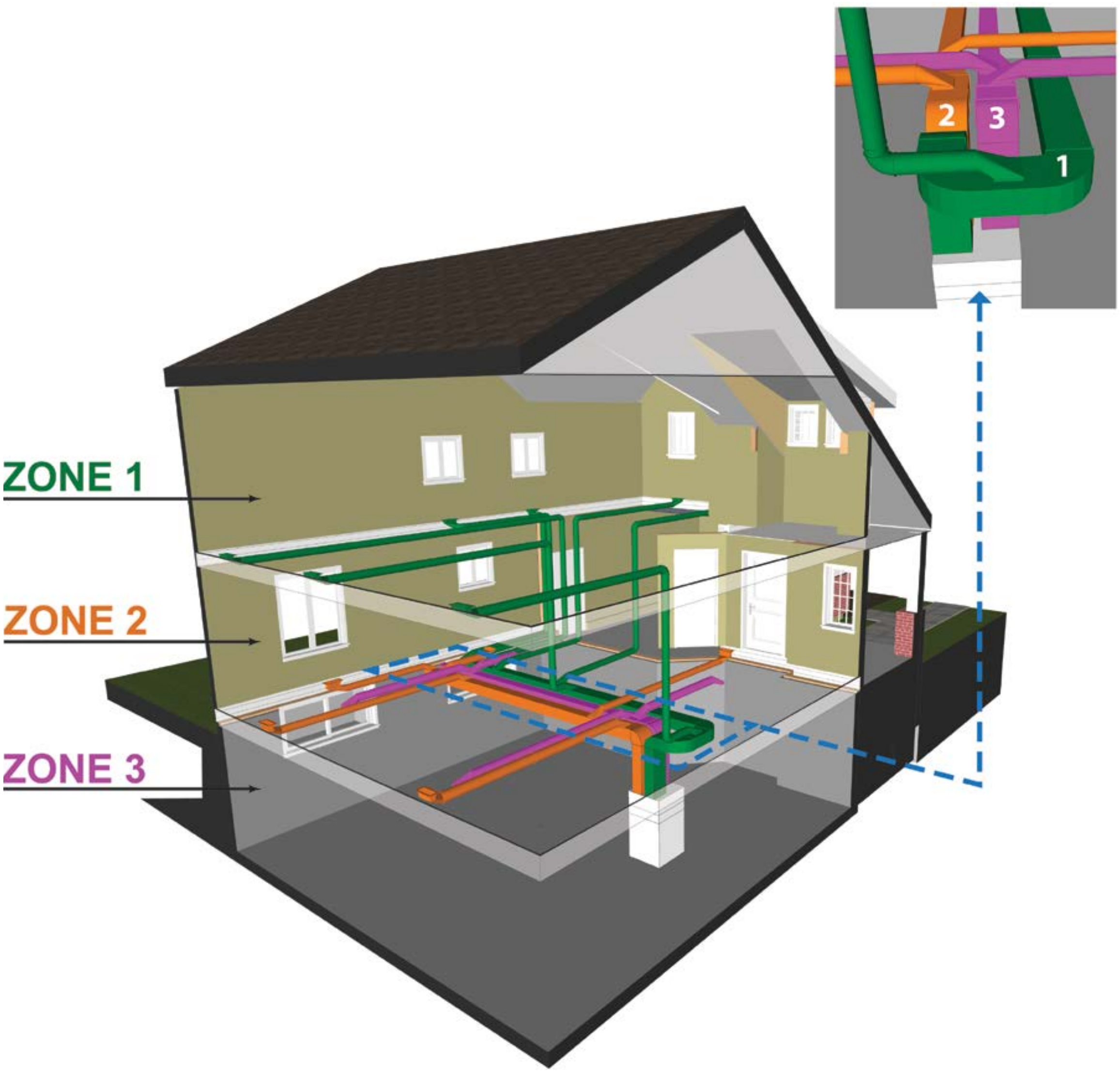


Figure 6: Example of a zoned supply-air duct design using three supply trunks, one for each level of a two-storey house with basement and close-up to show zoned plenum's.

OVERVIEW OF THE ZONING DECISIONS

Go to the last page of this document to access a full working copy of the **Zoning Checklist for Builders** to complete your design decisions both before and during your meeting with your mechanical designer.

DECISION 1: Choose the Type of House being zoned

DECISION 2: Divide the House into Zones

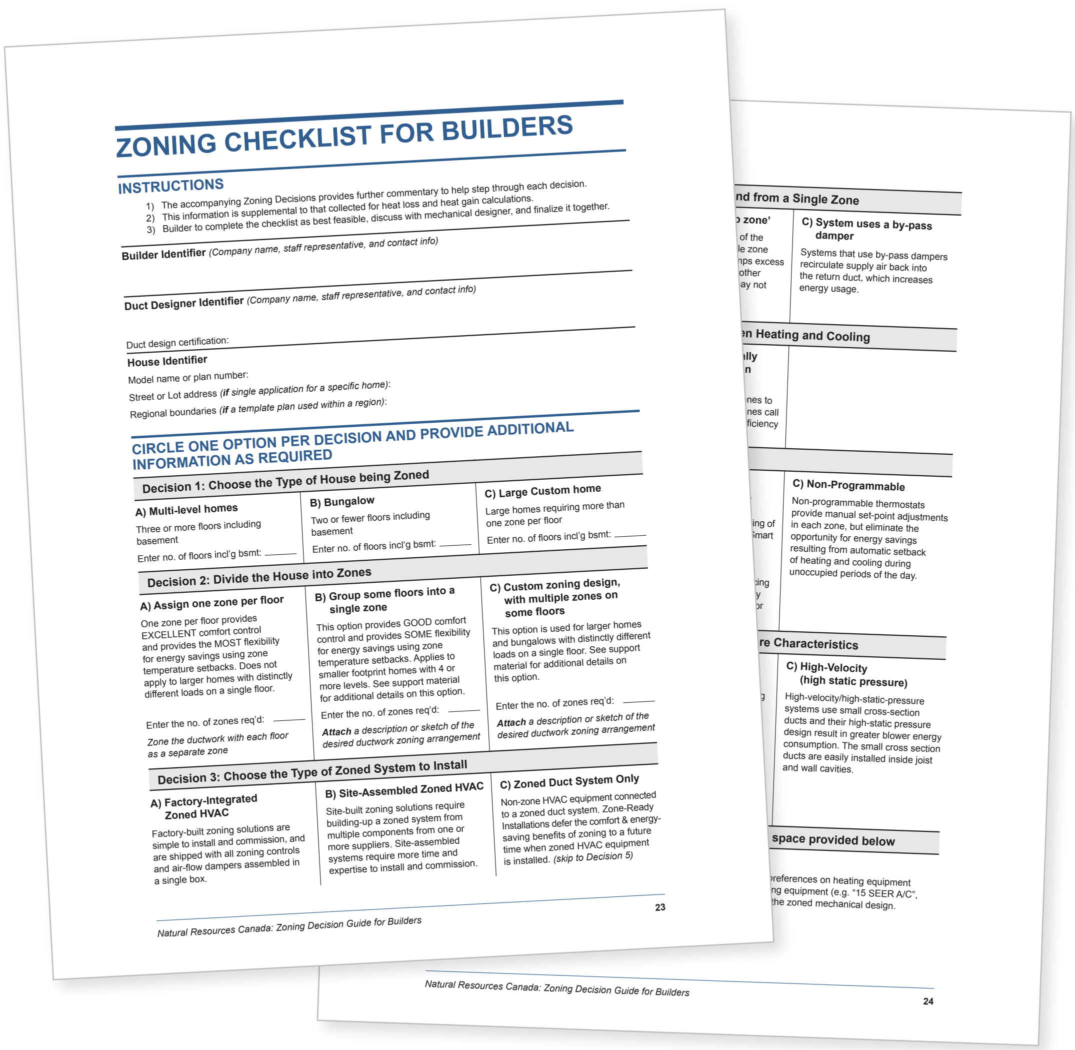
DECISION 3: Choose the Type of Zoned System to Install

DECISION 4: Choose Approach to Meeting a Demand from a Single Zone

DECISION 5: Choose Change-Over Approach between Heating and Cooling

DECISION 6: Choose Thermostat Type

DECISION 7: Choose Duct System Velocity/Static Pressure Characteristics


ZONING CHECKLIST FOR BUILDERS

INSTRUCTIONS
1) The accompanying Zoning Decisions provides further commentary to help step through each decision.
2) This information is supplemental to that collected for heat loss and heat gain calculations.
3) Builder to complete the checklist as best feasible, discuss with mechanical designer, and finalize it together.

Builder Identifier *(Company name, staff representative, and contact info)*

Duct Designer Identifier *(Company name, staff representative, and contact info)*

Duct design certification:

House Identifier
Model name or plan number:
Street or Lot address *(if single application for a specific home)*:
Regional boundaries *(if a template plan used within a region)*:

CIRCLE ONE OPTION PER DECISION AND PROVIDE ADDITIONAL INFORMATION AS REQUIRED

Decision 1: Choose the Type of House being Zoned

A) Multi-level homes	B) Bungalow	C) Large Custom home
Three or more floors including basement. Enter no. of floors incl'g bsmt: ____	Two or fewer floors including basement. Enter no. of floors incl'g bsmt: ____	Large homes requiring more than one zone per floor. Enter no. of floors incl'g bsmt: ____

Decision 2: Divide the House into Zones

A) Assign one zone per floor	B) Group some floors into a single zone	C) Custom zoning design, with multiple zones on some floors
One zone per floor provides EXCELLENT comfort control and provides the MOST flexibility for energy savings using zone temperature setbacks. Does not apply to larger homes with distinctly different loads on a single floor. Enter the no. of zones req'd: ____ *Zone the ductwork with each floor as a separate zone*	This option provides GOOD comfort control and provides SOME flexibility for energy savings using zone temperature setbacks. Applies to smaller footprint homes with 4 or more levels. See support material for additional details on this option. Enter the no. of zones req'd: ____ ***Attach** a description or sketch of the desired ductwork zoning arrangement*	This option is used for larger homes and bungalows with distinctly different loads on a single floor. See support material for additional details on this option. Enter the no. of zones req'd: ____ ***Attach** a description or sketch of the desired ductwork zoning arrangement*

Decision 3: Choose the Type of Zoned System to Install

A) Factory-Integrated Zoned HVAC	B) Site-Assembled Zoned HVAC	C) Zoned Duct System Only
Factory-built zoning solutions are simple to install and commission, and are shipped with all zoning controls and air-flow dampers assembled in a single box.	Site-built zoning solutions require building-up a zoned system from multiple components from one or more suppliers. Site-assembled systems require more time and expertise to install and commission.	Non-zone HVAC equipment connected to a zoned duct system. Zone-Ready Installations defer the comfort & energy-saving benefits of zoning to a future time when zoned HVAC equipment is installed. *(skip to Decision 5)*

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...nd from a Single Zone

C) System uses a by-pass damper
Systems that use by-pass dampers recirculate supply air back into the return duct, which increases energy usage.

...n Heating and Cooling

C) Non-Programmable
Non-programmable thermostats provide manual set-point adjustments in each zone, but eliminate the opportunity for energy savings resulting from automatic setback of heating and cooling during unoccupied periods of the day.

...re Characteristics

C) High-Velocity (high static pressure)
High-velocity/high-static-pressure systems use small cross-section ducts and their high-static pressure design result in greater blower energy consumption. The small cross section ducts are easily installed inside joist and wall cavities.

...space provided below

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Figure 7: An image of the 2-page Zoning Checklist for Builders available at the end of this document.

DECISION 1: CHOOSE THE TYPE OF HOUSE BEING ZONED

The type and size of house being built will help determine the number and arrangement of HVAC zones required to provide the enhanced comfort control and energy-saving flexibility made possible by zoning a home.

Option A: Houses with three or more floors, including basement

This housing type includes single-family, attached and detached homes with three or more floors, including basements, which can have similar heating and cooling loads across a given level.

This option does not apply to larger homes with distinctly different heating and cooling loads on a single floor (see Option C instead).

Figure 1-1: Examples of multi-storey houses

Option B: Bungalows

This housing type applies to bungalow designs with up to two floors, including basements, which have distinctly different occupancy usage (e.g. cooking and living versus sleeping) on a single floor.

Figure 1-2: Example of a single-storey bungalow

Option C: Large custom homes

This housing type is used for larger footprint, multi-storey homes which have distinctly different heating and cooling loads (e.g. large glazing areas on a particular elevation), and/or distinctly different occupancy usage on a single floor.

Figure 1-3: Example of a large footprint, multi-storey house

DECISION 2: DIVIDE THE HOUSE INTO ZONES

Most houses can be suitably divided into a few zones to satisfy both comfort and energy considerations. Areas of the house with:

- different heating and cooling requirements should be assigned separate zones;
- different expected occupancy patterns should be assigned separate zones.

Option A: Assign one zone per floor

One zone per floor provides EXCELLENT comfort control and provides the MOST flexibility for energy savings using zone temperature setbacks. This option does not apply to larger footprint homes with distinctly different heating and cooling loads on a single floor (see Option C).

If Option A is selected, each floor of the house will be assigned a separate zone.

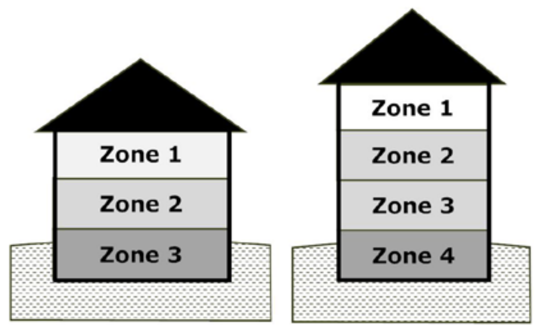

Figure 2-1: Examples of assigning one zone per floor

Option B: Group some floors into a single zone

This option provides GOOD comfort control and provides SOME flexibility for energy savings using zone temperature setbacks.

The lowest and highest floors in the home should each be independent zones to maximize comfort and efficiency.

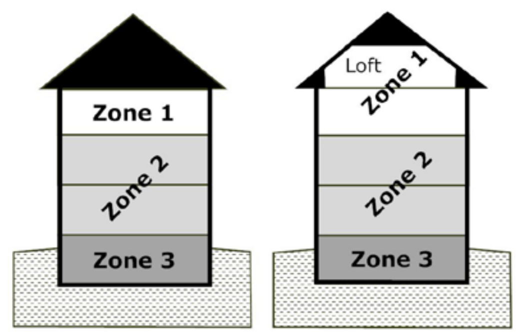

Figure 2-2: Examples of small footprint homes with some floors grouped into a single zone

- **Uppermost floors**, including lofts, are a distinct zone. Hot air tends to pool at the top of the house. During summer nights the main floor can cool sufficiently so that there are no cooling calls from a main-floor thermostat. With the air conditioning remaining off, the upper-floor temperatures can continue to remain high throughout the night. Zoning studies have shown that zoning upper floors will improve sleeping conditions at night. Zoning the upper floor can also help reduce the tendency to oversize air conditioning to compensate for poor cooling of upper floors. A separate upper-floor zone will also allow homeowners to use daytime cooling setback of the upper-floor zone to substantially reduce peak electricity usage during summer heat waves. A small Canadian zoning study showed that the upper floor called for 80% of the cooling demands during the afternoon peak period.
- **Intermediate floors** may have similar heating and cooling loads to each other. To reduce first costs, builders may be able to group a couple of intermediate floors together into a single zone.
- **Basements** are a distinct zone. They are at the bottom of the house where colder air is most likely to pool due to stack effects. Hourly basement heat loss and gains can be very different from above grade walls because they are more affected by seasonal soil temperatures than daily weather. A small Canadian zoning study showed that the basement zone never called for cooling during the summer. Zoning can be used to reduce the overcooling of basements during the summer and provide winter warmth when basements are occupied.

If Option B is selected, the builder should indicate which floors should be grouped together into a single zone.

The duct design professional will need to confirm the appropriateness of the proposed zoning approach based upon: room by room heat loss and gain calculation results, updated analysis of heating and cooling zones based on these calculations and the related implications on comfort and energy needs, and compatibility with the heating and cooling equipment selected.

Option C: Custom zoning design, with multiple zones on some floors

This option is used for larger homes and bungalows with distinctly different heating and cooling loads and occupancy patterns on a single floor.

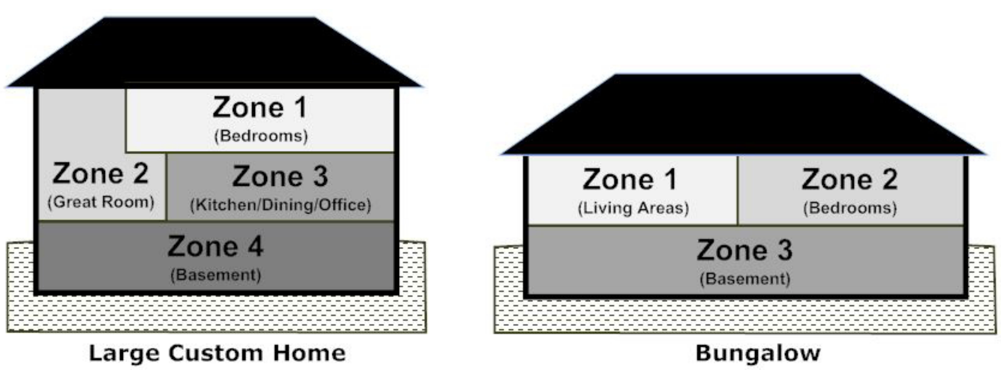

Figure 2-3: Examples of larger footprint homes with multiple zones per Floor

Large footprint houses are more likely to require more than one zone per floor including house designs with:

- different occupancy patterns in different areas of the same floor such as living and sleeping areas;
- large glazing areas on a particular elevation which impact heating and cooling loads in a portion of a given floor.

Some examples include:

Bungalows: Zones should be assigned to each level and functional area of the house. For example, bungalows with basements can have three zones: one cooking and living zone (Zone 1), one bedroom zone (Zone 2) and one basement zone (Zone 3). Figure 2-4 shows an example bungalow floor plan with the three zones assigned to the different areas.

Figure 2-4: Example floor plan of a bungalow with three zones defined

Distinctive Heating and Cooling Requirements: For example, in a large two-storey house with a "great room" having floor to ceiling windows, such a room may have distinct heating and/or cooling needs that may warrant consideration as a distinct zone to be serviced by its own supply trunk as illustrated in Figure 2-5.

If Option C is selected, the builder should sketch out the desired zoning arrangements on the plans for the house being considered, and attach these to the ***"Zoning Decision Checklist"***.

The duct design professional will need to confirm the appropriateness of the proposed zoning approach based upon: room by room heat loss and gain calculation results, updated analysis of heating and cooling zones based on these calculations and the related implications on comfort and energy needs, and compatibility with the heating and cooling equipment selected.

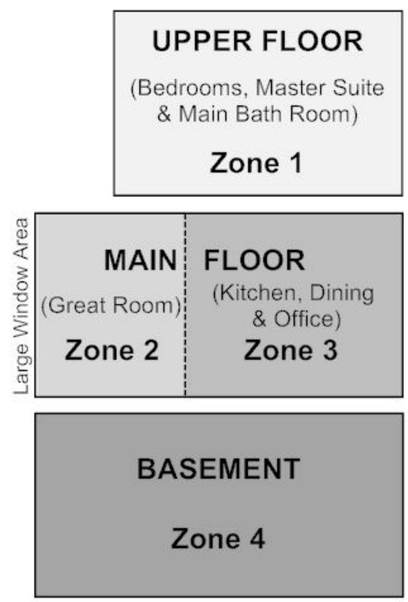

Figure 2-5: Example floor plan of a large house requiring two separate zones on the main floor

DECISION 3: CHOOSE THE TYPE OF ZONED HVAC SYSTEM TO INSTALL

The choice of Zoned HVAC System will impact the installation effort required, and determine the level of comfort and energy-saving features offered to the homebuyer.

Option A: Factory-integrated zoned HVAC system

Factory-integrated zoning solutions are shipped with all zoning controls and air-flow dampers pre-assembled in a single box. Equipment installation is straightforward, requiring duct connections to a Zone-Ready duct system and control wiring to one thermostat per zone. Installation and commission requirements of factory-integrated zoned equipment are similar to that of equivalent single-zone equipment. An example of a factory-integrated zoned system installation is shown in Figure 3-1.

Factory-integrated zoned HVAC systems will provide homebuyers with enhanced comfort and energy-saving features compared to single-zoned HVAC systems.

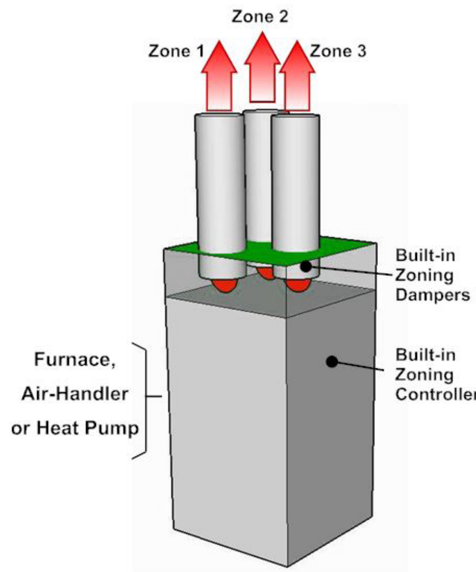

Figure 3-1: Example of a factory-integrated zoned heating system

Option B: Site-assembled zoned HVAC system

Site-assembled zoning solutions require building-up a zoned system from multiple components sourced from one or more suppliers. Equipment installation requires adding automatic zoning dampers to the Zone-Ready supply ducts, installing the external zoning controller, installing one thermostat per zone and then connecting the various components together using control wiring. Site-assembled zoned equipment will require more time and expertise to install than factory-integrated zoning solutions or single-zone equipment. An example of a site-assembled zoned system installation is shown in Figure 3-2.

Site-assembled zoned HVAC systems will provide home buyers with enhanced comfort and energy-saving features compared to single-zoned HVAC systems.

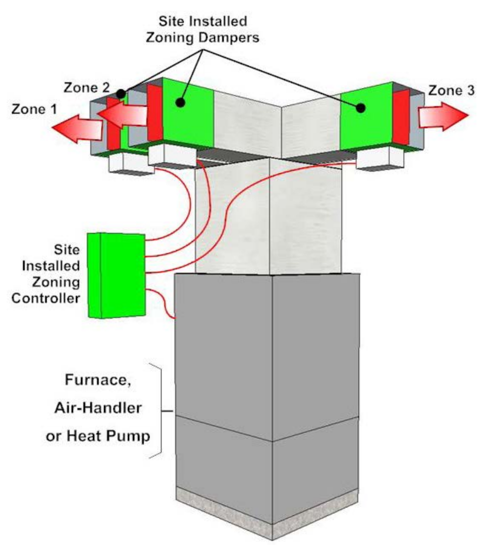

Figure 3-2: Example of a site-assembled zoned heating system

Option C: Zoned duct system only

In this option, a zoned duct system is installed with traditional single-zone HVAC equipment and a single main floor thermostat. The zoned duct system will improve system airflow effectiveness, helping conditioned air get to where it's intended to go, even when used in combination with traditional single-zone HVAC equipment. The zone duct system also enables a mechanically zoned system to be installed at a later date (i.e., the duct system is "Zone-Ready"). An example of a Zone-Ready System installation is shown in Figure 3-3.

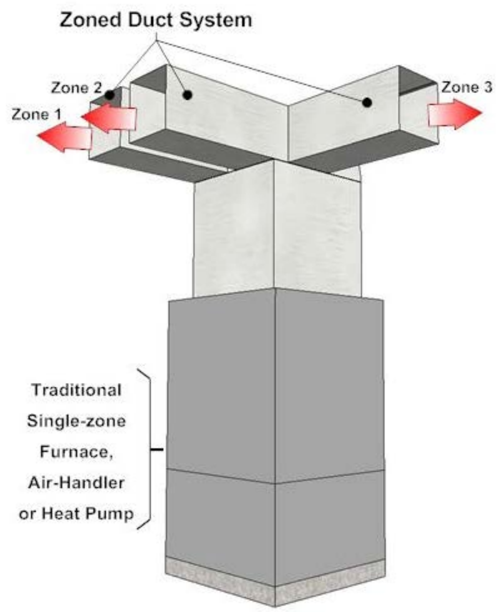

Figure 3-3: Example of a zone-ready heating system installation

As an additional service-related option, zone duct systems may be fitted with zone service dampers on each of the zone supply trunks. These dampers can be used to respond to potential comfort-related call backs, making field adjustments quick and easy to do. Field technicians would use the zone service dampers to adjust the distribution of conditioned air between zones to maximize comfort conditions during the winter heating and summer cooling seasons.

It is important to note that where a decision is made to install zone service dampers, they must be designed and installed to ensure that it is not possible to sufficiently restrict airflow to the point that air conditioning and heating equipment operate outside the minimum airflow conditions specified by the equipment manufacturers. In other words, if a homeowner inadvertently closes all of the zone service dampers at the same time, enough airflow must still pass through the ducts to ensure that the cooling coil will not freeze, and the furnace heat exchanger will not overheat. Stops fitted to the damper quadrant handles or trimmed damper blades are techniques that can be used by the installer to ensure this cannot occur.

DECISION 4: CHOOSE APPROACH TO MEET A DEMAND FROM A SINGLE ZONE

In a Zoned HVAC System, multiple zones are independently controlled by separate thermostats which can individually call for conditioned air. The heating and cooling equipment should adapt its operation in order to accommodate these zone demands. The way in which the equipment accomplishes this can influence the overall system efficiency and the type of heating and cooling equipment that is required.

Option A: System fully modulates or stages airflow

In Option A, the zoned system has a minimum airflow delivery that is less than or equal to the airflow that can be accepted by the smallest zone that could be calling as shown in Figure 4-1. Selecting this option will likely require the use of variable-capacity heating and variable-capacity air-conditioning equipment.

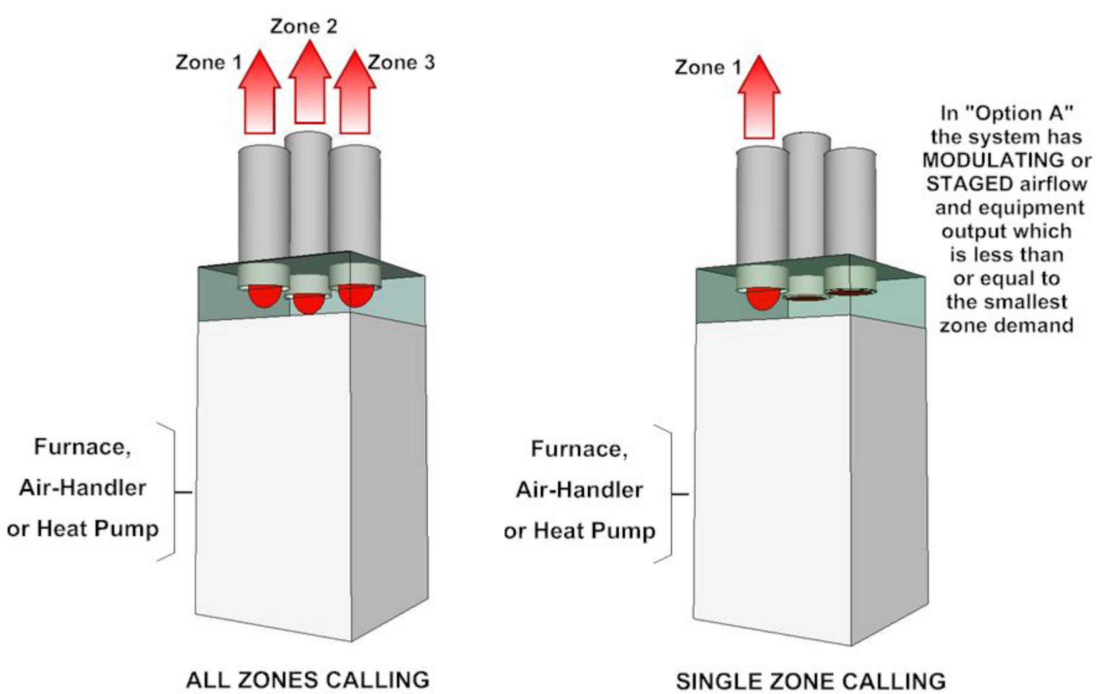

Figure 4-1: "Option A" has modulating or staged airflow to satisfy low zone demands

Option A provides the best comfort control and least energy consumption. This option can be implemented using either "factory-integrated" or "site-assembled" zoned equipment (Figure 4-1 shows a "factory-integrated" system).

Option B: System uses a "dump zone"

In Option B, when the minimum airflow delivery of the system is more than a single zone can accept, the system dumps excess heated or cooled air into another zone as shown in Figure 4-2. This type of system may or may not modulate or stage airflow and equipment output. For example, Option B is often implemented in zoned cooling systems using fixed-capacity air-conditioning equipment in order to provide sufficient minimum air-flow across the cooling coil to prevent freeze-up.

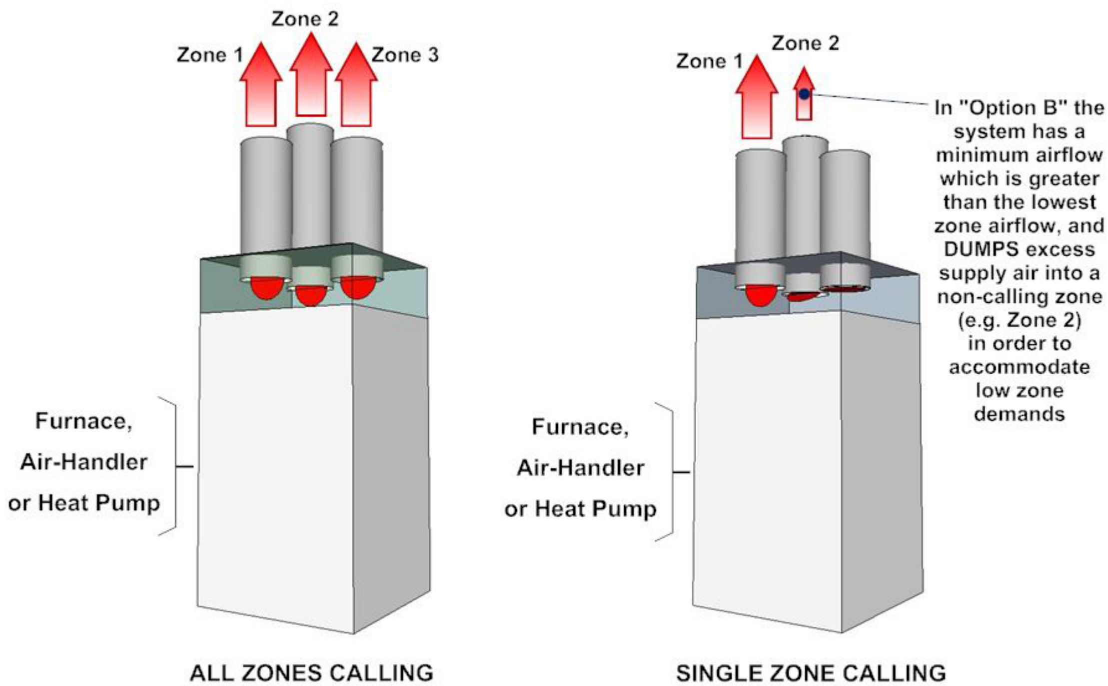

Figure 4-2: "Option B" dumps excess supply air into a non-calling zone to satisfy low zone demands

Option B provides good comfort control and low energy consumption. This option can be implemented using either "factory-integrated" or "site-assembled" zoned equipment (Figure 4-2 shows a "factory-integrated" system).

Option C: System uses a “by-pass damper”

In Option C, when the minimum airflow delivery of the system is more than a single zone can accept, the system dumps excess heated or cooled air into the return air stream as shown in Figure 4-3.

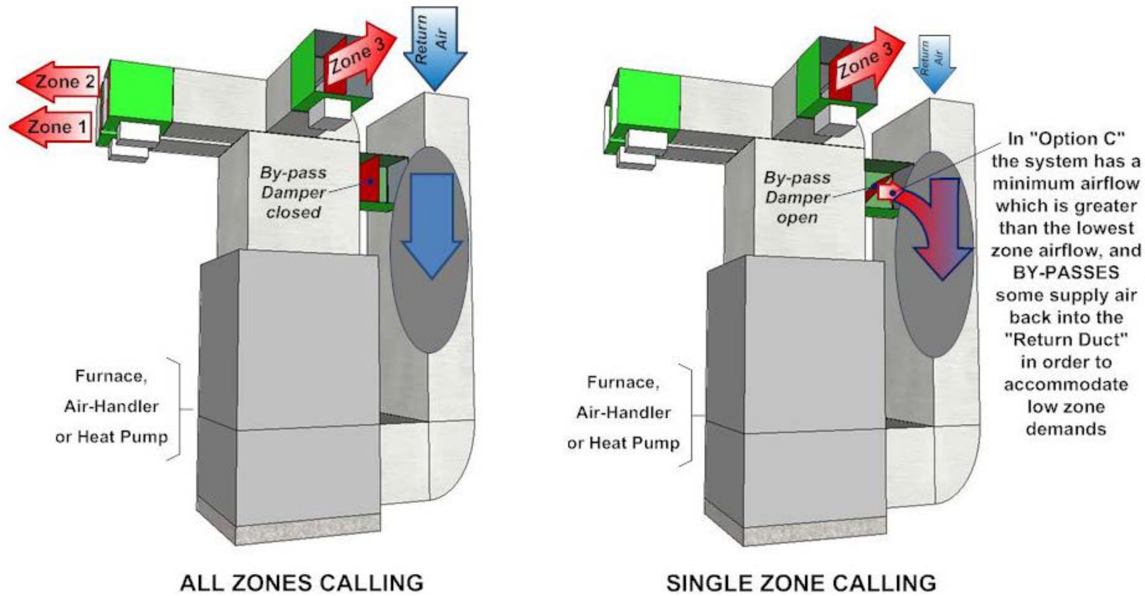

Figure 4-3: “Option C” by-passes excess supply air into the return-air duct to satisfy low zone demands

Option C provides good comfort control, however by-passing supply air into the return duct will lower system efficiency and increase energy usage. This option is implemented using “site assembled” components.

DECISION 5: CHOOSE CHANGE-OVER APPROACH BETWEEN HEATING AND COOLING

In a Zoned HVAC System, the heating and cooling equipment is connected to multiple heating and cooling thermostats which can individually call for conditioned air. The approach used to determine whether the system is in heating or cooling mode can significantly influence the overall system efficiency and annual energy consumption.

Option A: Controller enables manually switching of system from heating to cooling

With this option a central or master, manual changeover switch is used to determine whether the system is in heating or cooling mode (or off). All zones will deliver either heating or cooling, depending on the setting of the master system mode switch as shown in Figure 5-1.

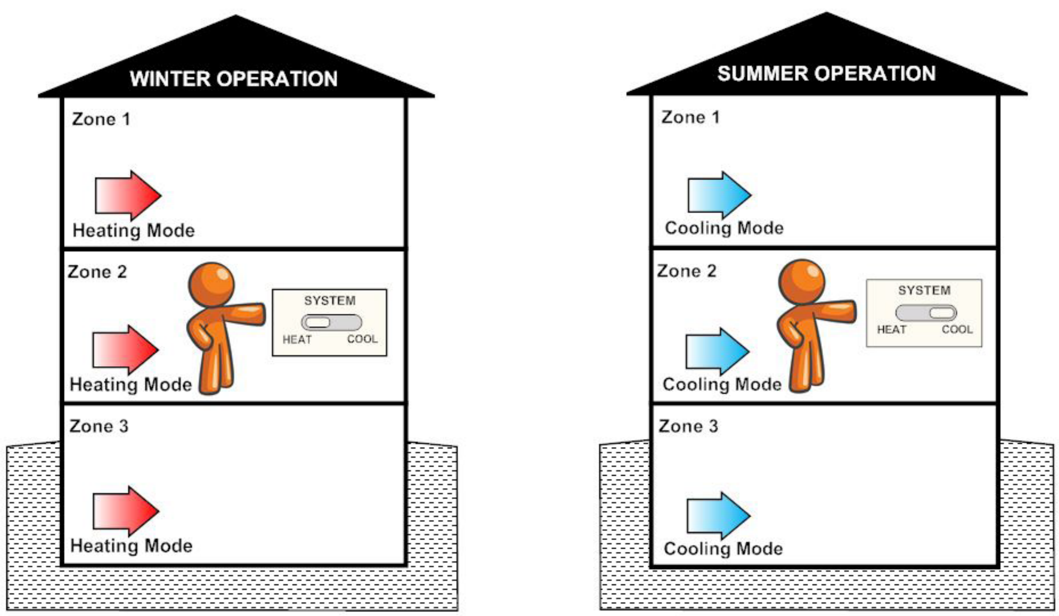

Figure 5-1: A manual system mode-switch determines whether all zones are either heated or cooled

This type of controller maximizes energy efficiency while providing excellent comfort in both the heating and cooling seasons.

Option B: Controller automatically switches the system from heating to cooling

With this option, the central zoning controller will allow some zones to be set to heating mode while other zones are set to cooling mode. This type of zoning controller responds to both heating and cooling calls from the zone thermostats by toggling the HVAC system from heating to cooling operation on alternative system operating cycles as shown in Figure 5-2.

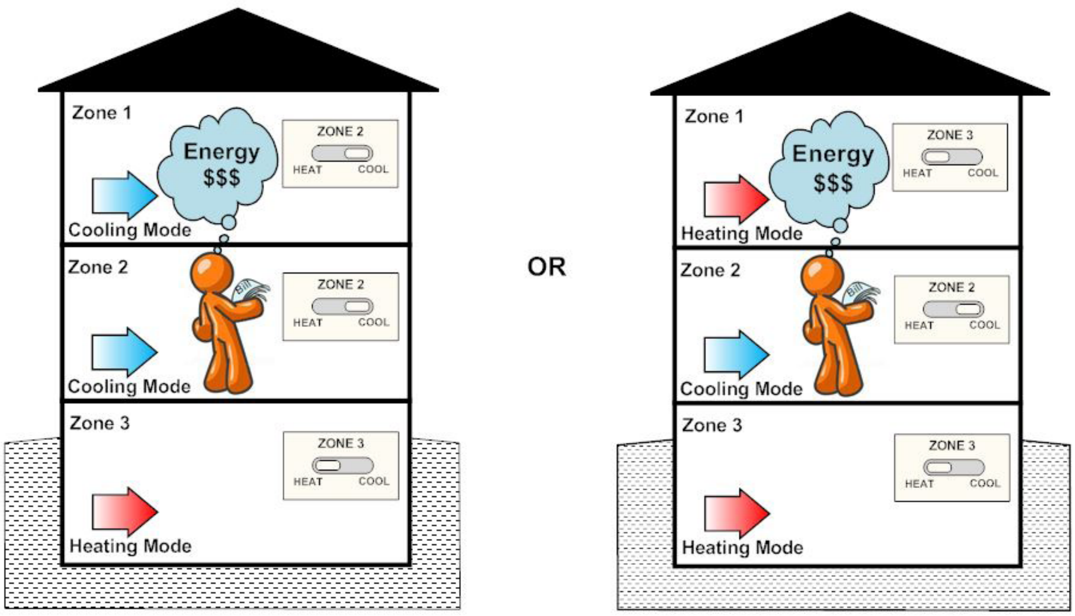

Figure 5-2: Examples of how automatic mode selection can allow both heating & cooling delivery to different zones

Although this type of controller can provide excellent comfort, it can significantly increase energy consumption and energy cost by delivering both heating and cooling to different zones within the house on any given day during the Spring, Summer or Fall, depending on the individual zone-thermostat mode settings. (In winter the air-conditioner operation will be locked out due to low outdoor temperature).

DECISION 6: CHOOSE THE THERMOSTAT TYPE

Zoned heating and cooling systems are controlled by multiple thermostats, with one thermostat installed in each zone within the house. Zoned systems are uniquely suited to benefit from heating and cooling scheduling to reduce energy usage by conditioning only the occupied zones of the house.

Option A and Option B provide homeowners with features which will help automate heating and cooling temperature scheduling. Homebuilders are encouraged to check with their local energy utilities for possible incentives available for installing certain types of programmable or smart thermostats.

Option A: Programmable thermostats

This type of thermostat provides homeowners with the ability to use daily temperature schedules for heating and cooling. A programmable thermostat in each zone will provide the ability for energy savings from scheduling regular setbacks of heating and cooling in the various zones during normally unoccupied periods of the day.

Many current generation programmable thermostats also provide WiFi connectivity which will allow homeowners to re-program or adjust temperature settings remotely using smart phones, tablets or computers.

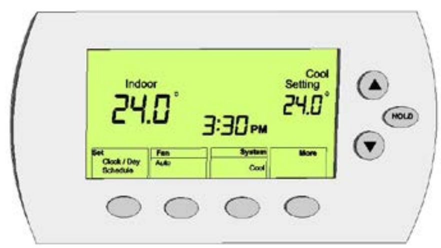

Figure 6-1: Programmable thermostats enable automatic temperature scheduling of the different zones

Option B: Smart thermostats

The “Smart thermostat” is a new class of product available from several manufacturers, which extends the functionality of the thermostat beyond fixed scheduling of temperature set-points and WiFi connectivity. Depending on the particular model, smart thermostats include such features as learning functions, predictive functions, adaptive sensors (e.g. motion, proximity, ambient light, etc.), and/or geo-fencing links to a smart phone to determine house occupancy and automatically adjust the temperature for both comfort and energy savings.

Figure 6-2: Smart thermostats automatically adapt temperature settings to improve comfort and reduce energy consumption

Smart Thermostats can do more than schedule temperature settings throughout the day, they automatically adapt their operation to improve comfort and reduce energy consumption.

Smart thermostats also include WiFi connectivity and may include additional features such as smart phone apps, voice controls and provision of energy reports on usage patterns to help users further optimize their heating and cooling energy usage.

Option C: Non-programmable thermostats

Non-programmable thermostats provide the homeowner with the ability to manually control their zoned heating and cooling system. However, the fixed temperature settings used by these thermostats will eliminate opportunities for energy savings resulting from the automatic setback of the different zones during unoccupied periods of the day.

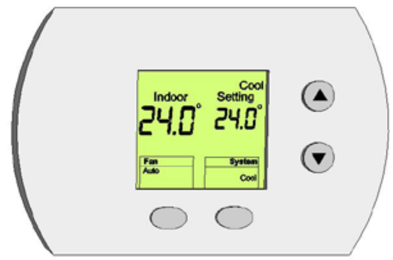

Figure 6-3: Non-programmable thermostats provide manual temperature control of the zoned system

DECISION 7: CHOOSE DUCT SYSTEM VELOCITY/STATIC PRESSURE CHARACTERISTICS

Traditionally duct systems have used low-velocity/low-static-pressure designs. Medium and high velocity options have become available. The builder and mechanical designer should discuss and agree on which option will be used before the zoned duct design is initiated.

Low-velocity, medium-velocity and high-velocity are common terms used to describe a range of ducting technologies which use different static pressures and duct sizes to deliver conditioned supply air to various parts of the house. Builders are encouraged to consult with their mechanical designers to learn more about the pros and cons of each ducting approach, and together decide which ducting technology is best for a given housing project.

The illustrations are intended to convey the relative air velocity and static pressure in the branch ducts of the different types of duct technologies, and are not necessarily representative of the actual connections of the ducts to the mechanical equipment.

Option A: Low-velocity/ Low-static-pressure ducting

Low-velocity systems have been the traditional market-dominant duct technology. An example of a low-velocity system is shown in Figure 7-1. These types of systems use larger cross-section ducts and their low-static pressure design minimizes blower energy consumption.

From an installation perspective, the larger cross-section ducts can be more challenging to integrate and install in joist and wall cavities. Some corner boxes and bulkheads may be required to conceal some ductwork.

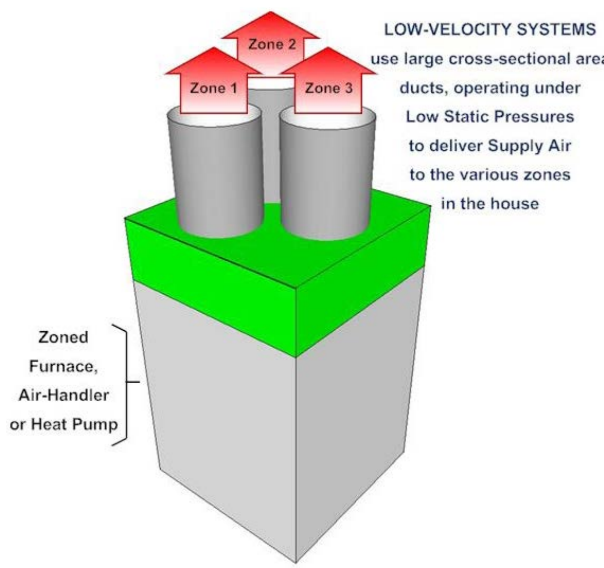

Figure 7-1: Low-velocity duct system

Option B: Medium-velocity/ Medium-static-pressure ducting

Medium-velocity systems, such as the one shown in Figure 7-2, are starting to be used as a “middle-of-the-road” option between low-velocity and high-velocity systems. Medium-velocity systems use medium cross-section ducts which result in medium static-pressures and slightly higher blower energy consumption than low-velocity systems.

From an installation perspective, the medium cross-section ducts are more easily integrated and installed in joist and wall cavities of the house.

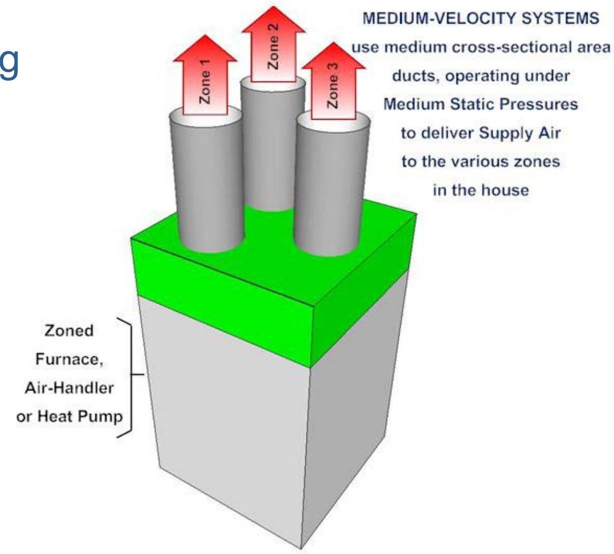

Figure 7-2: Medium-Velocity Duct System

Option C: High-velocity/ High-static-pressure ducting

High-velocity systems, such as the one shown in Figure 7-3, have been used for a number of years especially in the townhome segment. Their small cross-section ducts results in high-static pressures and higher blower energy consumption than both low-velocity and medium-velocity systems. High-velocity duct systems are typically proprietary designs and include approaches for muffling sounds associated with the high-velocity airflows.

From an installation perspective, the small cross-section ducts are more easily installed inside joist and wall cavities of the house.

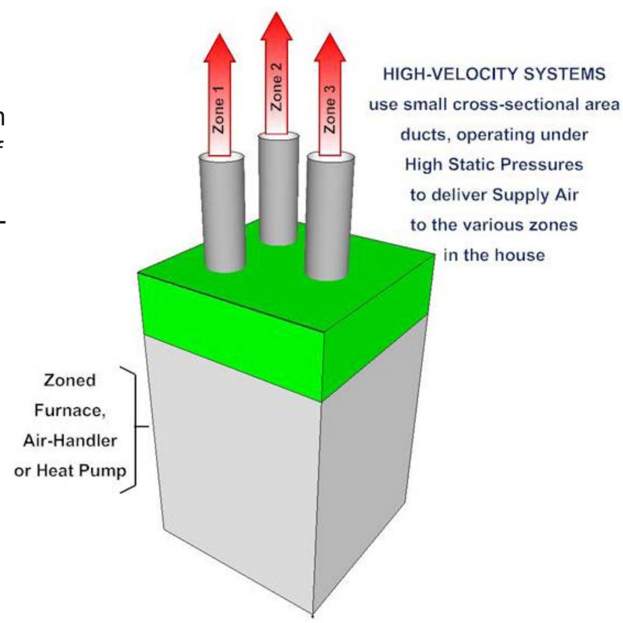

Figure 7-3: High-Velocity Duct System

ZONING CHECKLIST FOR BUILDERS

INSTRUCTIONS

1) The accompanying Zoning Decisions provides further commentary to help step through each decision.
2) This information is supplemental to that collected for heat loss and heat gain calculations.
3) Builder to complete the checklist as best feasible, discuss with mechanical designer, and finalize it together.

Builder Identifier *(Company name, staff representative, and contact info)*

Duct Designer Identifier *(Company name, staff representative, and contact info)*

Duct design certification:

House Identifier

Model name or plan number:

Street or Lot address *(**if** single application for a specific home)*:

Regional boundaries *(**if** a template plan used within a region)*:

CIRCLE ONE OPTION PER DECISION AND PROVIDE ADDITIONAL INFORMATION AS REQUIRED

Decision 1: Choose the Type of House being Zoned		
A) Multi-level homes Three or more floors including basement Enter no. of floors incl'g bsmt: ______	**B) Bungalow** Two or fewer floors including basement Enter no. of floors incl'g bsmt: ______	**C) Large Custom home** Large homes requiring more than one zone per floor Enter no. of floors incl'g bsmt: ______

Decision 2: Divide the House into Zones		
A) Assign one zone per floor One zone per floor provides EXCELLENT comfort control and provides the MOST flexibility for energy savings using zone temperature setbacks. Does not apply to larger homes with distinctly different loads on a single floor. Enter the no. of zones req'd: ______ *Zone the ductwork with each floor as a separate zone*	**B) Group some floors into a single zone** This option provides GOOD comfort control and provides SOME flexibility for energy savings using zone temperature setbacks. Applies to smaller footprint homes with 4 or more levels. See support material for additional details on this option. Enter the no. of zones req'd: ______ ***Attach** a description or sketch of the desired ductwork zoning arrangement*	**C) Custom zoning design, with multiple zones on some floors** This option is used for larger homes and bungalows with distinctly different loads on a single floor. See support material for additional details on this option. Enter the no. of zones req'd: ______ ***Attach** a description or sketch of the desired ductwork zoning arrangement*

Decision 3: Choose the Type of Zoned System to Install		
A) Factory-Integrated Zoned HVAC Factory-built zoning solutions are simple to install and commission, and are shipped with all zoning controls and air-flow dampers assembled in a single box.	**B) Site-Assembled Zoned HVAC** Site-built zoning solutions require building-up a zoned system from multiple components from one or more suppliers. Site-assembled systems require more time and expertise to install and commission.	**C) Zoned Duct System Only** Non-zone HVAC equipment connected to a zoned duct system. Zone-Ready Installations defer the comfort & energy-saving benefits of zoning to a future time when zoned HVAC equipment is installed. ***(skip to Decision 5)***

Decision 4: Choose Approach to Meeting a Demand from a Single Zone

A) System fully modulates or stages airflow	B) System uses ‘dump zone’	C) System uses a by-pass damper
This type of system has a minimum airflow that is less than or equal to the flow that can be accepted by the smallest zone that could be calling. It provides the best comfort, control and least energy consumption.	When the minimum airflow of the system is more than a single zone can accept, the system dumps excess heated or cooled air into another zone. The system may or may not modulate or stage airflow.	Systems that use by-pass dampers recirculate supply air back into the return duct, which increases energy usage.

Decision 5: Choose Change-Over Approach Between Heating and Cooling

A) Controller enables occupant to seasonally switch-over from heating to cooling	B) Controller automatically switches over between heating and cooling	
This type of controller maximizes energy efficiency and comfort. A central, manual change-over control is used.	Controllers that allow some zones to call for heating while other zones call for cooling will lower system efficiency and increase energy usage.	

Decision 6: Choose Thermostat Type

A) Programmable	B) ‘Smart’ Programmable	C) Non-Programmable
A programmable thermostat in each zone provides the ability to save energy by using zone setbacks during unoccupied periods.	The “Smart thermostat” is a new class of product which extends functionality beyond fixed scheduling of temperature and WiFi connectivity. Smart thermostats may include learning or predictive functions, adaptive sensors (e.g. motion, proximity, ambient light, etc.), and/or geo-fencing links to determine occupancy. They automatically adjust temperature for both comfort and energy savings.	Non-programmable thermostats provide manual set-point adjustments in each zone, but eliminate the opportunity for energy savings resulting from automatic setback of heating and cooling during unoccupied periods of the day.

Decision 7: Choose Duct System Velocity/ Static-Pressure Characteristics

A) Low-Velocity (low static pressure)	B) Medium-Velocity (medium static pressure)	C) High-Velocity (high static pressure)
Low-velocity systems are the traditional market-dominant duct technology. They use larger cross-section ducts and their low-static pressure design minimizes blower energy consumption. The large cross-section ducts can be more challenging to integrate and install in joist and wall cavities.	Medium-velocity systems are starting to be used as a “middle-of-the-road” option between low and high velocity systems. Medium-velocity systems use medium cross-section ducts which result in medium static pressures and slightly higher blower energy consumption than low-velocity systems. The medium cross-section ducts are more easily integrated and installed in joist and wall cavities.	High-velocity/high static pressure systems use small cross-section ducts and their high-static pressure design result in greater blower energy consumption. The small cross-section ducts are easily installed inside joist and wall cavities.

Please provide any other instructions or Zoned System Design preferences below

Please indicate any other General Instructions. This could include such things as preferences on heating equipment (e.g. “NG furnace”, “multi-stage or modulating furnace” “combo system”, etc), cooling equipment (e.g. “15 SEER A/C”, “multi-stage or modulating A/C condenser”, etc), or other specific requirements for the zoned mechanical design.