Integrated Dehumidification Solution

White Paper
July 2018

An innovative approach to moisture removal for home health and humidity management

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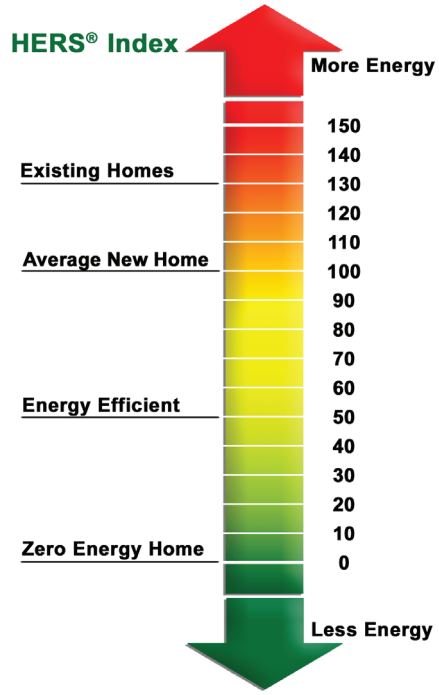
Humidity Issues Impacting Building Health and Comfort

Today's highly energy-efficient homes have highly insulated enclosures and airtight construction and often require mechanical ventilation to bring fresh air into the indoor environment. These high-performance homes conserve resources and save money on heating and cooling bills, but can suffer negative effects from high humidity levels at certain times of year in a number of U.S. regions. Increased humidity levels have a significant impact on builders and architects, who are responsible for the health of their buildings, as well as homeowners, who seek to live in a comfortable, safe indoor environment year-round.

Addressing the issue of high humidity requires a basic understanding of the Home Energy Rating System (HERS). HERS is the industry standard by which home energy performance is measured—much like the miles-per-gallon sticker on cars—giving prospective buyers and homeowners an insight as to how the home ranks in terms of energy efficiency. A lower number indicates a more efficient home: For example, a home built to the 2006 International Energy Conservation Code (IECC) will receive a rating of around 100, while a more recent home built to 2015 IECC would rate closer to 70. (Inefficient older homes can have a rating of 150 or even higher.) Ultimately, the industry is pushing toward a net-zero trend—meaning that a home produces as much energy as it consumes through renewable resources.[1]

While high-performance homes reduce energy use, the National Renewable Energy Laboratory (NREL) and Department of Energy (DOE) recognize that they also have an impact on indoor environments:



- As homes in humid climates have become more energy efficient, there is evidence that relative humidity levels in homes have been increasing.[2]
- As heating and cooling loads are shrinking, supplemental dehumidification may be required.[3]

CHALLENGE

Relative humidity, or the amount of water vapor in the air, is an important health variable that is easy to overlook, yet very easy to remedy. Ideal humidity is generally described as between 40 percent and 60 percent. High-humidity indoor environments present several major issues with regard to building health and human comfort. Excessive humidity can cause problems with odor, mold, and mildew, and even peeling paint, water damage, or loss of structural integrity in the most severe cases. Developers, builders, and architects all have a vested interest in minimizing these issues, including in homes that are unoccupied for extended periods. For homeowners, high humidity goes beyond affecting the condition of their home's interior and furnishings: When indoor relative humidity rises above 60%, occupants of a home are going to feel sticky and clammy in addition to potentially being exposed to the harmful effects of mold, mildew, bacteria, and dust mites—making the environment particularly hazardous for people with asthma and allergies.

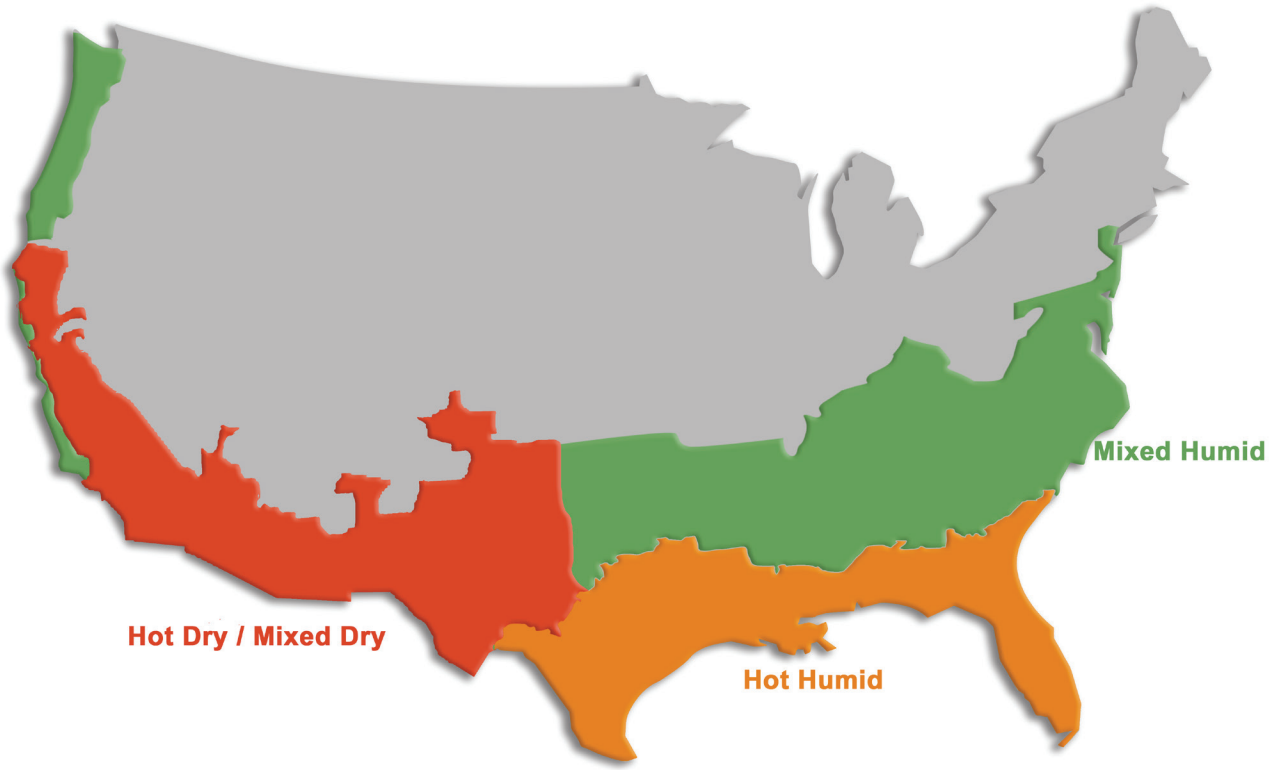
1 HERSindex.com

2 ASHRAE Research Project Report 1449-RP, "Energy Efficient and Cost Assessment of Humidity Control Options for Residential Buildings"

3 National Renewable Energy Laboratory (NREL), "Building America Roadmap Overview: Optimal Comfort Systems for Low-Load Homes"

GEOGRAPHY

During the warmest seasons in areas with generally high humidity—such as the Gulf Coast and Southeast U.S.—regular heat pump or air conditioning cycles efficiently maintain humidity levels; in the coolest seasons, when outdoor conditions are drier, high humidity is not an issue. In the so-called shoulder seasons of spring and fall, when temperatures are in the mid-60s and 70s, significantly lower heating and cooling loads are required. The relative humidity, however, may be quite high. As a result, typical indoor moisture sources and outdoor ventilation air can cause the indoor relative humidity to rise to uncomfortable levels.



STRIKING A BALANCE

Although there are a number of ways and system types to address excessive relative humidity, there is no silver bullet. Some existing solutions require additional system components such as high-end, whole-home dehumidifiers or low-end portable units. Others rely on over-cooling to remove humidity from the home, which can lead to temperature fluctuations up to 3°F off a thermostat set-point, resulting in increased energy usage and potential discomfort. Ultimately, each moisture-removal solution comes with pros and cons, and factors such as initial cost of ownership, payback time, and energy usage all must be balanced against building health, human comfort and health concerns, and even ease of use. In this white paper, we will explain how the Trane Integrated Dehumidification Solution (IDS) uses a simple but cost-effective method appropriate for this segment—servicing an unmet need for architects, homebuilders, and homeowners in a number of geographical regions in the United States. Although it is primarily targeted toward energy-efficient homes, Trane IDS can be incorporated into any home in which value-oriented humidity control is desired.

How The Trane Integrated Dehumidification Solution Works

IDS takes a practical approach to the excessive-humidity problem, pairing a specialized Trane thermostat with compatible Trane air conditioning units, heat pumps, and variable-speed air handlers. When needed, home occupants can set the thermostat control to three levels of dehumidification (low/medium/high), depending on the comfort level desired. When too much humidity is detected in the house, the IDS will run for a defined amount of time out of each hour. (Note: To adhere to code requirements, IDS is only available when the system is in cooling mode. See Appendix for additional detail.)

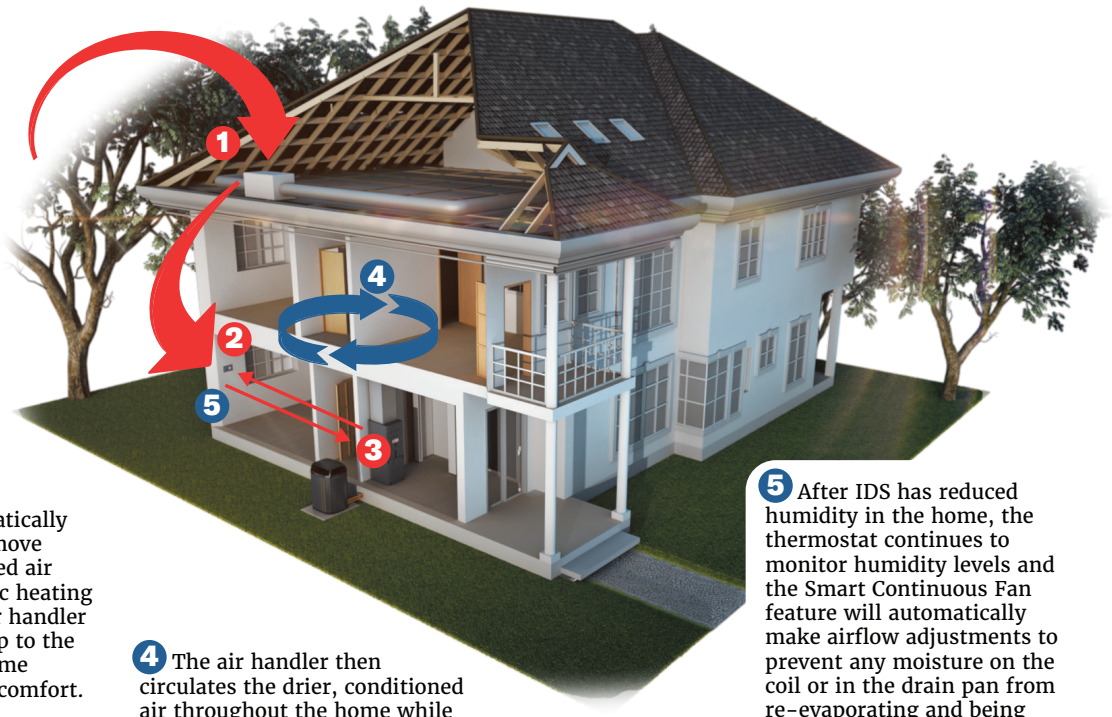
With IDS, home temperature is maintained without over-cooling. A heater located within the variable-speed air handler is an independent operating feature/mode and can be activated when too much humidity is detected, even if cooling is not needed. The result is a more predictable lowering of humidity all while maintaining home comfort levels.

In basic terms, the IDS uses the dehumidification function of the cooling coils in conjunction with the warming function of electric heat in order to remove moisture while maintaining neutral, comfortable temperatures within the home.

1. Indoor Humidity levels increase due to internal sources or moist air brought in from the outside.

2. Thermostat detects that humidity exceeds the user-set preference of low, medium, or high, depending on desired comfort level, and commands the HVAC system to turn on cooling, electric heat, and the variable speed air handler.

3. The system automatically senses the need to remove moisture and the cooled air passes over the electric heating element within the air handler and is warmed back up to the temperature of the home providing continuous comfort.



4. The air handler then circulates the drier, conditioned air throughout the home while IDS operates.

5. After IDS has reduced humidity in the home, the thermostat continues to monitor humidity levels and the Smart Continuous Fan feature will automatically make airflow adjustments to prevent any moisture on the coil or in the drain pan from re-evaporating and being introduced back into the home.

IDS System Components

Outdoor
Heat Pump or
Air Conditioner

Unique XL824
or XL1050 Control

Variable Speed
Indoor
Air Handler

Mechanical Ventilator
(not required in all homes)

Why Trane IDS is Needed and the Benefits It Provides

The market needs a technology that will provide year-round comfort in energy-efficient homes at the lowest upfront cost. There are two specific customer groups that can benefit from incorporating Trane IDS into their HVAC systems:

RESIDENTIAL BUILDERS/ARCHITECTS

The home construction industry is acutely aware of the problems caused by high indoor humidity levels, both from the perspective of homeowner satisfaction as well as the health of their buildings when vacant, prior to purchase. For those designing and building residential homes, Trane IDS represents a cost-effective option for basic dehumidification, given the low initial price and simple, fast installation.

- Numerous builders and architects have requested Trane's assistance to address these concerns. Trane IDS provides a value-oriented, integrated solution that makes financial and practical sense:
- Lower initial cost of systems, due to use of existing Trane HVAC units that are compatible—rather than having to purchase separate equipment and accessories.
- Similarly, use of those familiar product lines simplifies installation, minimizing labor costs and time on-site.
- Effective removal of humidity from vacant homes protects their investment from hazards of mold, mildew, and odors, as well as the resulting callback issues.
- More comfortable indoor climates result in increased homeowner satisfaction.

HOMEOWNERS

Occupants of energy-efficient homes need fresh air, but they also want to be comfortable and protected from issues such as mold, mildew, and odors. During winter and summer in humid regions of the United States, HVAC units effectively remove moisture from the air. During the shoulder seasons, when temperatures are moderate and homes require less heating or cooling, indoor humidity can rise to uncomfortable levels.

For value-minded homeowners, Trane IDS provides several advantages:

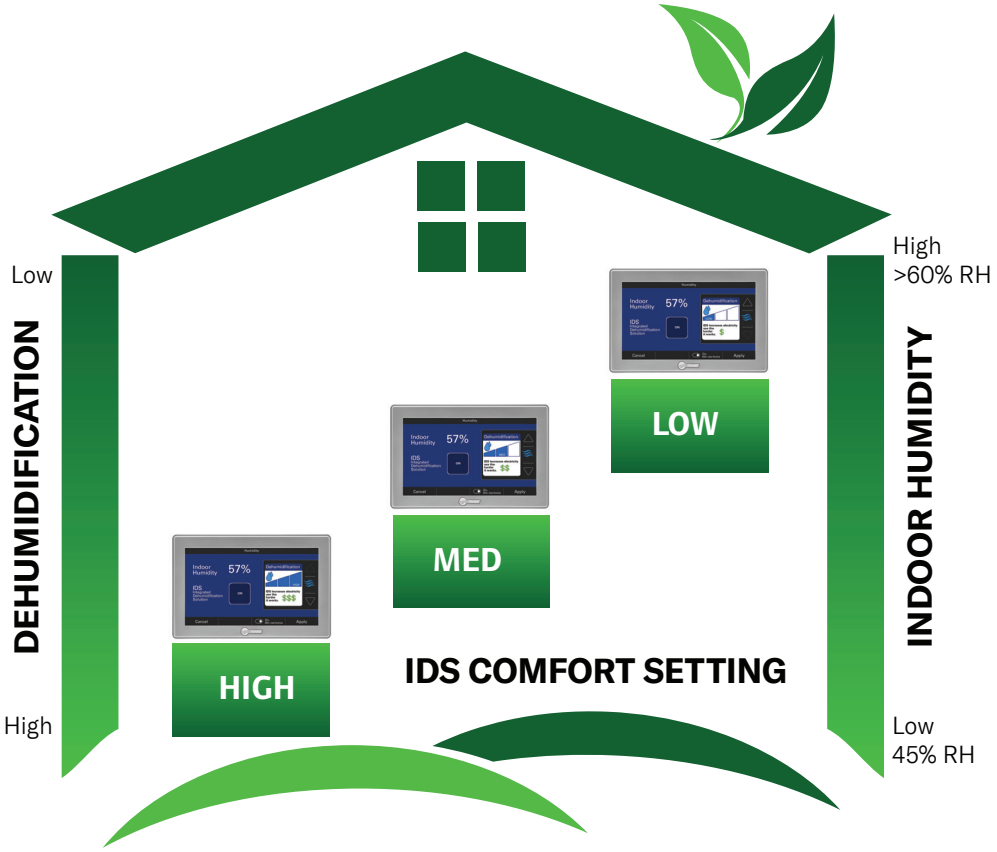
- Low initial cost of ownership. (See additional discussion below.)

- Whole-house dehumidification through existing ductwork.
- Creates more comfortable environment.
- Mitigates health issues from mold and mildew.
- Ease of use—interaction done with familiar thermostat programming via simple user interface offers low-medium-high levels, keeping relative humidity under 60% and as low as 45%[4].
- No maintenance required beyond regular servicing of the standard equipment.

4 The relative humidity in individual homes will vary based on outdoor conditions and installation. If more specific set points are desired, another solution—such as a whole-house dehumidifier—may be recommended.

An Economical Solution for Removing Infrequent High Humidity

Trane IDS is an economical solution for the value-conscious consumer who desires whole-house dehumidification at a reasonable cost. Given that extreme high humidity occurs infrequently and for relatively few hours on an annual basis, the Trane IDS system represents an efficient approach to the problem.



LOW INITIAL COST OF OWNERSHIP

Trane IDS requires only a specialized thermostat at a nominal incremental cost and compatible variable-speed indoor blower equipment.

TYPICAL COST OF OPERATION

Given how and when it is used, Trane IDS offers moderate cost of operation. To cite one example, an external consultant performed building energy-usage simulations and found that electricity costs to operate the IDS function could be around $50-$100 a year to remove extreme humidity events (greater than 60% relative humidity) in a HERS 50, 2,000-square-foot home in Orlando, Florida.[5]

Viewing initial cost of ownership and energy consumption together, it is clear why Trane IDS makes economic sense for this market: requiring only a nominal upgrade that pays for itself in comfort and building health immediately after installation.

Finally, it is worth mentioning that Trane IDS offers advantages over portable units: It provides higher dehumidification capacity and distributes dehumidified air throughout the house to meet comfort and building health needs.

5 Figures based on national average electricity cost of 12 cents/kWh as reported by the State of Florida in March 2018. Specific energy costs could vary based on region.

Building Code Interpretation and Explanation

From a 30,000-foot perspective, the purpose of the energy code is to make sure that all of the reasonable things you can do to save energy inside a building are being done. Construction materials, methods, and appliances must meet certain requirements, for example, with every element of a home working in unison to reduce heating and cooling loads. So, too, the codes and appliance standards dictate the required efficiency of the heating and cooling systems themselves, most notably with requirements in Seasonal Energy Efficiency Ratio (SEER) and Heating Season Performance Factor (HSPF) ratings.

One of the elements of the code addresses the use of electric resistance heat sources. Electric resistance heat cannot be used when the heat pump is capable of addressing the heating load on its own, typically when the outdoor temperature is between 35-55°F. To comply with the code, systems are designed to lock out simultaneous use of heat pump heating and electric resistance heating—i.e., a user's attempt to accelerate the warming process—by only allowing the latter when the mode selector is on heat and supplemental heat is not needed to meet the heating load. This is a reasonable, commonsense requirement for appropriate energy usage.

It's important, therefore, to understand that Trane IDS adheres to the principles, application, and even spirit of the energy code, even if such use is not explicitly addressed within the current code. The IDS feature will only run in order to function as a dehumidifier; it is not intended to heat the living space. Like other building components, the electric resistance heat in this circumstance is serving a very specific purpose: to address building health and occupant comfort. Again, the programming of the IDS-compatible thermostat restricts the use of dehumidification only to when the mode selector is set on cool and indoor humidity reaches uncomfortable/unsafe levels. It is disabled and cannot run when set to heat.

Trane IDS Provides an Answer To an Unmet Need

One of the smartest things you can do for a home is to maintain the proper humidity levels. In addition to comfort, a living space that isn't too dry or too damp carries benefits across the board, from maintaining overall health to keeping the home in better operating condition and extending its life from an investment perspective.

Energy code changes in the past 10 years have dramatically improved the efficiency of modern homes, but the unintended consequences of high-humidity indoor environments—in terms of building health as well as human comfort—must be addressed. Trane takes its responsibility seriously to bring solutions to the table that can mitigate the resulting issues.

Trane IDS represents an innovative approach to the problem for homes in regions of the United States that have high humidity during moderate temperature seasons. Although the IDS solution has been designed specifically for high-efficiency homes, it can be employed in any situation requiring a value-based approach to dehumidification. By using existing, familiar heating and cooling equipment in conjunction with an IDS-enabled thermostat, Trane IDS delivers a dehumidification solution that is effective, affordable, and code compliant—making it ideal for homebuilders as well as homeowners.

Appendix

1. IDS COMPATIBLE MODELS AND SYSTEM CONFIGURATION

Thermostat	Inline Ventilator Fan Kit w/Relay**	6" Motorized Damper Kit	Air Handler Models	ELECTRIC HEATER KIT OPTIONS (+ EXTRA DIGIT)		Outdoor Models
Unique Models of Trane XL824 TCONT824AS52DARHC or XL1050 TZON1050AC52ZARHC	EVENQF130V1NAAA Additional Accessories: E1650024 - Heater Model EQH400 E1650025 - Heater Model EQH900 E1650123 - 2 Pack 10x10x2 Filter	E1650026 Additional Accessories: E1955001 - 6" Screened Wall Cap	TEM6A0B24H21SBA	BAYHTR1505BRK+	BAYHTR1508BRK+*	Compatible with all Trane Outdoor Units
			TEM6A0B30H21SBA	BAYHTR1505BRK+	BAYHTR1508BRK+*	
			TEM6A0C36H31SBA	BAYHTR1508BRK+	BAYHTR1510BRK+	
			TEM6A0C42H41SBA	BAYHTR1508BRK+	BAYHTR1510BRK+	
			TEM6A0C48H41SBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM6A0C60H51SBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM6A0D48H41SBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM6A0D60H51SBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM8A0B24V21DBA	BAYHTR1505BRK+	BAYHTR1508BRK+	
			TEM8A0B30V31DBA	BAYHTR1505BRK+	BAYHTR1508BRK+	
			TEM8A0C36V31DBA	BAYHTR1508BRK+	BAYHTR1510BRK+	
			TEM8A0C42V41DBA	BAYHTR1508BRK+	BAYHTR1510BRK+	
			TEM8A0C48V41DBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM8A0C60V51DBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM8A0D48V41DBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TEM8A0D60V51DBA	BAYHTR1510BRK+	BAYHTR1517BRK+	
			TAM9A0A24V21DAA	BAYEAAC05BK1B+	BAYEAAC08BK1B+	
			TAM9A0B30V31DAA	BAYEAAC05BK1B+	BAYEAAC08BK1B+	
			TAM9A0C36V31DAA	BAYEAAC08BK1B+	BAYEAAC10BK1B+	
			TAM9A0C42V41DAA	BAYEAAC08BK1B+	BAYEAAC10BK1B+	
			TAM9A0C48V41DAA	BAYEAAC10BK1B+	BAYEABC15BK1B+	
			TAM9A0C60V51DAA	BAYEAAC10BK1B+	BAYEABC15BK1B+	

* AH/Heater combination can not be matched with a HP Outdoor Unit
** Ventilation solutions are recommended when you have the following situations: Spray Foam Insulated Home or Home was built after 2013, as ASHRAE 62.2 would apply

2. STATE BUILDING CODE REQUIREMENTS

2015 IECC, SECTION R403.1.2

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

2016 CALIFORNIA TITLE 24, SECTION 110.2(B)

Heat pumps with supplementary electric resistance heaters shall have controls:

1. That prevent supplementary heater operation when the heating load can be met by the heat pump alone; and

2. In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating.

EXCEPTION 1 to Section 110.2(b): The controls may allow supplementary heater operation during:

A. Defrost; and

B. Transient periods such as start-ups and following room thermostat setpoint advance, if the controls provide preferential rate control, intelligent recovery, staging, ramping or another control mechanism designed to preclude the unnecessary operation of supplementary heating.

EXCEPTION 2 to Section 110.2(b): Room air-conditioner heat pumps.

2015 WASHINGTON STATE ENERGY CODE, SECTION R403.1.2

Unitary air cooled heat pumps shall include controls that minimize supplemental heat usage during start-up, set-up, and defrost conditions. These controls shall anticipate need for heat and use compression heating as the first stage of heat. Controls shall indicate when supplemental heating is being used through visual means (e.g., LED indicators). Heat pumps equipped with supplementary heaters shall be installed with controls that prevent supplemental heater operation above 40°F. At final inspection the auxiliary heat lock out control shall be set to 35°F or less.

2018 NORTH CAROLINA ENERGY CODE, SECTION R403.1.2 (PROPOSED)

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load.

A heat strip outdoor temperature lockout thermostat shall be provided to prevent supplemental heat operation in response to the thermostat being changed to a warmer setting. The lockout shall be set no lower than 35°F and no higher than 40°F.

EXCEPTION :

1. In lieu of a heat strip outdoor temperature lockout thermostat, the following time and temperature electric-resistance control may be used. After six minutes of compressor run time in heat mode, supplemental electric heat shall energize only if the leaving air temperature from the indoor coil is below 90°F. If the indoor coil leaving air temperature exceeds 100°F, supplemental heat shall automatically de-energize, but allow the compressor to continue to operate until the call is satisfied. No thermostat shall initiate supplemental electric heat at any time. Thermostat controlled emergency heat shall not be limited by outdoor temperature. Electric resistance supplemental heat during defrost shall operate normally without limitation.

2. In lieu of a heat strip outdoor temperature lockout thermostat, a programmable indoor thermostat with the capability to minimize the use of supplementary electrical resistance heat using an automatic temperature ramp up control feature shall be acceptable.

2018 GEORGIA ENERGY CODE, SECTION R403.1.2 (APPROVED)

Heat pumps having supplementary electric-resistance heat shall have controls that, except during defrost, prevent supplemental heat operation when the heat pump compressor can meet the heating load. Except in Emergency heating mode, the supplementary electric-resistance heat may not energize unless the outdoor temperature is below 40°F (4°C).