

Proposal Summary



Residential HVAC Performance

Updated: April 2, 2023

Prepared by: Kristin Heinemeier, Frontier Energy

Introduction

The document summarizes proposed revisions to the California Energy Code (Title 24, Part 6) that will be discussed during a utility-sponsored stakeholder meeting on January 24, 2023. The Statewide Utility Codes and Standards Enhancement (CASE) Team is seeking input and feedback.

In this document, [TBD] indicates that the CASE Team is working on the proposal for specific requirements.

To participate or provide information, please email Kristin Heinemeier, kheinemeier@frontierenergy.com and cc info@title24stakeholders.com.

Data may be provided anonymously.

Measure Description

The Residential HVAC Performance CASE Report documents a set of proposals designed to ensure that Residential HVAC systems perform efficiently and effectively, providing comfort and protecting the condition of the equipment, in the following areas:

- Design
- Crankcase Heating
- Supplementary Heating Control
- Defrost
- Refrigerant Charge Verification
- Variable Capacity/Zoned Systems

The six measures described in the CASE Report are mostly mandatory measures, with a few prescriptive measures and alternatives. They generally apply to both single-family and multi-family buildings, and to new construction as well as additions and alterations. They include no new HERS measures and include a proposal to allow for remote verification of refrigerant charge in lieu of on-site verification.

The table below provides a summary of the required measures. Every effort was made to simplify these measures, while adding rigor to some processes such as load calculations and refrigerant charge verifications. These measures reflect an increased emphasis on the design process. Especially with the increased interest in installing heat pumps, design is critical to ensuring performance and maintaining comfort.

Mandatory in all climate zones and all building types, unless specified.

Scope refers to what system or building types the requirements apply to:

ADD/ALT = additions & alterations (not new construction).

HVAC = heating only systems, air conditioners, heat pumps; AC = air conditioners; HP = heat pumps

	Requirement	Scope	Notes
Design	Assume no greater than “average” envelope leakage in Manual J.	HVAC, ADD/ ALT	Alternative: establish envelope leakage with a blower door test.
	Use simplifying assumptions in Manual J, described in a new Residential Appendix.	HVAC	Allowed for like-for-like (or reduced size) replacements or small additions. Not allowed when installing a heat pump with strip heater.
	Include Manual J report on CF1R.	HVAC	
	Include list of ducts/diffusers on CF1R.	HVAC	
	Select a system with a heating capacity no less than the Manual J heating load.	HVAC	
	Select an AC or HP with a total cooling capacity no more than one half ton greater than the Manual J total cooling load.	AC/HP	Required when: Manual J total cooling load is greater than the Manual J heating load by no more than one ton, and Airflow is less than 350cfm/ton.
	Select a HP with a heating capacity no more than one ton greater than the Manual J heating load.	HP	
Select an AC or HP with total cooling capacity at the lowest speed less than 80% of the Manual J total cooling load, if it is variable capacity or multi-speed.	AC/HP		
Crankcase Heating	Select an AC or HP with documentation that it has no Crankcase heating (CCH), or that the CCH turns off when the compressor is on.	AC/HP	
	<i>(Prescriptive)</i> Install an Occupant Controlled Smart Thermostat.	AC/HP	Alternative: AC or HP has documentation that it has no CCH or the CCH is thermostatically controlled.
Supplementary	Select HP strip heating that has a capacity of no more than 2.7 kW/ton.	HP	If strip heating is used.

Heating Control	Select a HP that can lock out supplementary heating above a given temperature. Manufacturer must supply simple one-page instructions.	HP	
	Install and properly configure HP supplementary heating controls to lock out above the Manual J Heating Design Temperature or 25°F (whichever is greater).	HP	If supplementary heating is used (strip heater or dual-fuel backup).
De-frost	Set defrost delay timer to ≥90 minutes	HP	If the system utilizes a defrost delay timer.
Charge Verification	<i>(Prescriptive)</i> Use existing HERS refrigerant charge weigh-in observation procedures and measure system capacity.	AC in CZ 1, 3-7, 16; HP in All CZ	Alternatives: Upload all weigh-in and capacity test documentation for remote verification. Single speed systems may do standard charge test with HERS verification. Variable capacity systems may use manufacturers procedures.
VC/Z	Test fan efficacy with one zone calling.	HVAC	For zoned/variable capacity systems.

Data Needs/Stakeholder Information Requests

The measure developers are still seeking feedback and data on:

Energy Savings –

Seeking feedback on reasonableness of assumptions in modeling.

Technical Feasibility –

Seeking feedback on feasibility of all measures and level of burden on contractors.

Seeking feedback on how these measures would differ from manufacturer to manufacturer.

Market Readiness –

Seeking feedback on the prevalence of these measures currently, including available product characteristics and contractor design and installation practices.

Seeking information on availability and functionality of new tools for measures such as sizing and charge verification.

Non-energy Benefits –

Seeking feedback on peak demand performance of heat pumps.
Seeking data on comfort impacts of heat pumps,
Seeking data on impact on equipment health with proper and improper installation.

Costs –

Seeking data on the incremental labor and materials first costs for measures.

Seeking data on Operational Costs including any changes in maintenance costs and EUL

Economic Impacts –

Seeking data on current and projected adoption of heat pumps in general and HVAC systems with features impacted by measures.

Draft Code Language

The draft code language will propose revisions to Standard sections 110.2 and 150.0, and 150.1, as well as modifications to RA3.2.3, and removal of JA6.1 and RA3.4 and creation of a new RA.

The proposed changes to the Standards and Reference Appendices are provided below. Changes to the 2022 documents are marked with underlining (new language) and ~~strikethroughs~~ (deletions). These modifications are subject to change as the proposals are finalized.

Standards

SUBCHAPTER 2 ALL OCCUPANCIES—MANDATORY REQUIREMENTS FOR THE MANUFACTURE, CONSTRUCTION AND INSTALLATION OF SYSTEMS, EQUIPMENT AND BUILDING COMPONENTS

— SECTION 110.2 – MANDATORY REQUIREMENTS FOR SPACE-CONDITIONING EQUIPMENT

(b): Controls for heat pumps with supplementary ~~electric-resistance~~ heaters.

1. Heat pumps with supplementary ~~electric-resistance~~ heaters shall have controls that use either an outdoor air temperature sensor or an internet weather feed to lock out supplementary heating whenever the outdoor temperature exceeds the local winter 99% DB design temperature or 25°F, whichever is higher. Thermostat or heat pump manufacturer shall provide the installer with a simple one-page description of the proper configuration and verification of configuration of these 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)1: The controls may allow supplementary heater operation during ~~A. Defrost; and for emergency operation.~~

~~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)1: Room air-conditioner heat pumps.

~~2. When electric resistance strip heating is used, capacity is limited to the maximum of the difference between the heat heating capacity at the heating design temperature and the heating design load, and [TBD] kw per nominal ton (for defrost).~~

SUBCHAPTER 7 – SINGLE-FAMILY RESIDENTIAL BUILDINGS – MANDATORY FEATURES AND DEVICES

— SECTION 150.0 – Mandatory Features and Devices

(h) Space-conditioning equipment.

1. **Building cooling and heating loads.**

~~i. Building heating and cooling loads shall be determined using a method based on any one of the following:~~

~~A. The ASHRAE Handbook, Equipment Volume, Applications Volume and Fundamentals Volume; or~~

~~B. The SMACNA Residential Comfort System Installation Standards Manual; or~~

~~C. The ACCA Manual J.~~

Exception to Section 150.0(h)i: ~~For like-for-like system replacements where the conditioned floor area per replaced equipment nominal cooling tonnage is above that in Table XXX, sizing calculations need not be made.~~

	<u>(glazing %...)</u>		
<u>(design cooling temperature...)</u>	<u>600 sqft/ton</u>		
		<u>UNDER CONSTRUCTION</u>	

ii. The cooling and heating loads are two of the criteria that shall be used for equipment sizing and selection.

iii. The sizing report shall be included in the Certificate of Compliance.

iv. For new systems serving an addition with a conditioned floor area of 144 square feet or less, or for system replacements where the new equipment is the same type and the same or lower capacity as the replaced equipment, simplifying assumptions described in RA[NEW] are allowed, unless the space conditioning systems is a heat pump with supplementary electric resistance heating.

v. For additions and alterations, the envelope leakage used in the load calculation shall be no greater than “average”. A disclosure to the homeowner shall be provided that states that whole building leakage was not measured, the space-conditioning system may be undersized, and additional infiltration reduction measures may improve comfort.

Exception to Section 150.0(h)1v: A higher envelope leakage value may be used in the load calculations and no disclosure is required if leakage is established through field verification and diagnostic testing following procedures specified in Reference Residential Appendix RA3.8.

vi. Note: Heating systems are required to have a minimum heating capacity adequate to meet the minimum requirements of the CBC. The furnace output capacity and other specifications are published in the Commission’s directory of certified equipment or other directories approved by the Commission. For heat pumps, this refers to the capacity of the heat pump itself, not including any supplementary heating provided.

2. **Design conditions.** For the purpose of sizing the space- conditioning (HVAC) system, the indoor design temperatures shall be 68°F for heating and 75°F for cooling. Outdoor design conditions shall be selected from Reference Joint Appendix JA2, which is based on data from the ASHRAE 2021 Climatic Data for Region X. The outdoor design temperatures for heating shall be no lower than the 99.0 percent Heating Dry Bulb Heating Winter Median of Extremes values. The outdoor design temperatures for cooling shall be no greater than the 1.0 percent Cooling Dry Bulb and Mean Coincident Wet Bulb values.

[...]

5. **Heating and cooling ducts.** Documentation of the air distribution system shall be included in the Certificate of Compliance, either as a duct diagram or a room by room list, that provides, for each supply and return fixture, the required air capacity (CFM), diffuser dimensions, room throw, and manufacturer’s throw (at a given air velocity).

6. **System selection.** Heating-only systems shall be sized based on ACCA Manual S-2023, Table N2.5. Heat pumps and cooling-only systems shall be sized based on ACCA Manual S-2023, substituting these limits (where referenced, the Manual J load shall be the calculated load at the relevant design condition):

A. If the Manual J Total Cooling Design Load is greater than the Heating design Load, then the selected Total Cooling Capacity shall be no more than Manual J Total Cooling Load + 6,000 Btuh and the Heating Capacity shall be no more than Manual J Heating Load + 12,000 Btuh.

B. For multi- and variable-speed systems in existing buildings, if the Manual J Total Cooling Design Load is greater than the Heating Design Load, the lowest speed Total Cooling Capacity shall be no more than 80% of the

Manual J Total Cooling Load, and the lowest speed Heating Capacity shall be no more than the Manual J Heating Load. If the Manual J Heating Design Load is greater than the Total Cooling design Load, the lowest speed Heating Capacity shall be no more than 80% of the Manual J Heating Load, AND the lowest speed Total Cooling Capacity shall be no more than the Manual J Total Cooling Load.

Exception to Section 150.0(h)6: these maximum capacity limits can be waived if system airflow is at least 350 cfm/nominal system tons or if the Manual J Total Cooling Design Load exceeds the Manual J Heating Design Load by more than 12,000 Btuh.

7. **Defrost.** If a heat pump is equipped with a defrost delay timer, the delay timer must be set to greater than or equal to 90 minutes and verified by a HERS Rater according to the procedures specified in Reference Residential Appendix Section RA#####.

8. **Crankcase heating.** If an air conditioner or heat pump is equipped with crankcase heating, the crankcase heater shall be controlled to not operate when the compressor is operating.

(m) Air-distribution and ventilation system ducts, plenums and fans.

13. Space conditioning system airflow rate and fan efficacy. Space conditioning systems that utilize forced air ducts to supply cooling to an occupiable space shall:

C. **Zonally controlled central forced air systems.** Zonally controlled central forced air cooling systems shall be capable of simultaneously delivering, in every zonal control mode, an airflow from the dwelling, through the air handler fan and delivered to the dwelling, of greater than or equal to 350 cfm per ton of nominal cooling capacity, and operating at an air-handling unit fan efficacy of less than or equal to the maximum W/CFM specified in Subsections i or ii below. The airflow rate and fan efficacy requirements in this section shall be confirmed by field verification and diagnostic testing in accordance with the applicable procedures specified in Reference Residential Appendix RA3.3.

i. 0.45 W/CFM for gas furnace air-handling units.

ii. 0.58 W/CFM for air-handling units that are not gas furnaces.

Exception 1 to Section 150.0(m)13C: Multispeed or variable speed compressor systems, ~~or single speed compressor systems that utilize the performance compliance approach,~~ shall incorporate controls that vary fan speed with respect to the number of zones calling and shall demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 150.0(m)13C by operating the system at maximum compressor capacity and system fan speed with all zones calling for conditioning, rather than in every zonal control mode.

Exception 2 to Section 150.0(m)13C: Zonally controlled forced air heat pump systems utilizing a single compressor to serve multiple air handlers shall demonstrate compliance with the airflow (cfm/ton) and fan efficacy (Watt/cfm) requirements of Section 150.0(m)13C using the sum of airflows and Watt/cfm of all air handlers.

[...]

SECTION 150.1 – PERFORMANCE AND PRESCRIPTIVE COMPLIANCE APPROACHES FOR SINGLE-FAMILY RESIDENTIAL BUILDINGS

— SECTION 150.1(c) – Prescriptive standards/component packages

7. **Space heating and space cooling.** All space heating and space cooling equipment shall comply with minimum Appliance Efficiency Regulations as specified in Sections 110.0 through 110.2 and meet all applicable requirements of Sections 150.0 and 150.1(c)7A.
- A. Refrigerant charge. When refrigerant charge verification ~~or fault indicator display~~ is shown as required by Table 150.1-A, the system shall comply with either Section 150.1(c)7Ai or 150.1(c)7Aii:
- i. air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems, and mini-split systems, shall comply with subsections a, b and c, unless the system is of a type that cannot be verified using the specified procedures:

[...]

- c. The installer shall charge the system according to manufacturer's specifications. Refrigerant charge shall be verified according to one of the following options, as applicable:

[...]

~~ii. The system shall be equipped with a fault indicator display (FID) device that meets the specifications of Reference Joint Appendix JA6. The installer shall verify the refrigerant charge and FID device in accordance with the procedures in Reference Residential Appendix Section RA3.4.2. The HERS Rater shall verify FID device in accordance with the procedures in Section RA3.4.2; or~~

[...]

- ii. Air-cooled air conditioners and air-source heat pumps, including but not limited to ducted split systems, ducted packaged systems, small duct high velocity systems and mini-split systems, which are of a type that cannot comply with the requirements of Section 150.1(c)7Ai shall comply with Subsections a ~~through d and b~~, as applicable.

[...]

~~c. Systems for which charge cannot be tested must utilize low-leakage fittings [definition TBD].~~

~~d. Systems may use a method recommended by the manufacturer.~~

~~**Exception 2 to Section 150.1(c)7A:** Pre-charged systems with line set length less than 25' per air handler, and a matched coil are not required to have refrigerant charge verification.~~

~~B. Crankcase heating. Crankcase heating must meet one of the following:~~

- ~~i. Installer provides manufacturer documentation that the equipment does not have CCH.~~
- ~~ii. If $P_{w,off}$ values are below the Federal Efficiency Standard limits, the installer provides manufacturer's intermediate values "P1" and "P2" that are used in calculating the~~

reported $P_{w,off}$ values, per AHRI 210/240, to allow accurate modeling of connected power and control.

- iii. Installer installs an Occupant Controlled Smart Thermostat, per JA5.
- iv. Installer provides manufacturer documentation showing that CCH control includes either thermostatic control (disabling CCH above a fixed setpoint no higher than 55°F or differential temperature between crankcase and evaporator or condenser) or Positive Temperature Coefficient Control, and provides manufacturer’s intermediate values “P1” and “P2” that are used in calculating the reported $P_{w,off}$ values, per AHRI 210/240, to allow accurate modeling of connected power and control.

Table 150.1-A COMPONENT PACKAGE – Single Family Standard Building Design

			Climate Zone															
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
HVAC System	Space Heating	<u>Refrigerant Charge Verification (for Heat Pumps)</u>	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ
	Space Cooling	Refrigerant Charge Verification or Fault Indicator Display	NR	REQ	NR	NR	NR	NR	NR	REQ	REQ	REQ	REQ	REQ	REQ	REQ	REQ	NR

Reference Appendices

~~Joint Appendix 6.1: Fault Indicator Display (FID) (deleted in its entirety)~~

RA3.2.3 Weigh-In Charging Procedure

[...]

RA3.2.3.1 HVAC Installer - Weigh-In Charging Procedure

Split system air conditioners and heat pumps are shipped from the factory charged with a standard amount of refrigerant as indicated on the nameplate. The manufacturer-supplied refrigerant charge is expected to be the correct amount for the system based on a standard liquid line length and diameter. It is the responsibility of the HVAC installer to ensure that the charge is correct for each air conditioner and to adjust the charge based on liquid line dimensions that deviate from the manufacturer's standard line specification.

[...]

RA3.2.3.1.5 Weigh-in Procedure

The weigh-in procedure shall be performed in accordance with all manufacturer specifications to document and confirm:

[...]

- (g) The delivered capacity is measured and found to be close to the rated delivered capacity, either in heating or cooling mode.

The HVAC Installer shall certify on the Certificate of Installation that the manufacturer's specifications for these procedures have been met.

RA3.2.3.2 HERS Rater – In Person Observation of Weigh-In Charging Procedure

[...]

- (e) The test of measured delivered capacity.

Exception to RA3.2.3.2: : Vacuum documentation and capacity measurement are not required if verification is provided that all fittings (except the fitting to the compressor) are low-leakage type **definition TBD**.

RA3.2.3.3 HERS Rater – Remote Verification of Weigh-In Charging Procedure

When the Standards indicate this procedure is required, or is an option for compliance, the HVAC Installer shall collect and the HERS Rater shall coordinate with the installer to receive documentation of the weigh-in procedure. All documentation shall be transmitted to the HERS Rater, who shall review the documents to confirm that the adjustments and tests conform with the requirements of RA3.2.3.1.5.

This documentation shall consist of the following:

- (a) Documentation that the system was evacuated to 500 microns or less and, when isolated, rose no more than 300 microns over five minutes (for example, vacuum gauge photographs, or electronic instrument records).
- (b) Assumptions that were used to calculate the total charge or lineset correction based on the length and diameter of the lineset, including the liquid line filter drier if required per outdoor condensing unit manufacturer instructions (for example, estimated distance between units and vertical line lengths, line set assumed by manufacturer, excess line set length, adjustment for indoor coil(s) as recommended by manufacturer, filter dryer). The indoor coil correction to refrigerant weight if it is supplied by the manufacturer.
- (c) The amount of charge calculated for the lineset correction or the total charge based on lineset, indoor coil, and standard label charge.
- (d) The amount of charge added or removed (for example, before and after scale photographs, or electronic instrument records).
- (e) The measured delivered capacity of unit (for example, photographs, or electronic instrument records).

Exception to RA3.2.3.2: : Vacuum documentation and capacity measurement are not required if verification is provided that all fittings (except the fitting to the compressor) are low-leakage type **definition TBD**.

RA3.4 – ~~Field Verification of Installed HVAC System Components and Devices~~

- ~~○ RA3.4.2 Fault Indicator Display (FID) Verification Procedure~~
 - ~~▪ RA3.4.2.1 Verification of installation of a FID with "self diagnostic reporting" functionality when outdoor air temperature is less than 55F~~

- ~~RA3.4.2.2 Verification of Installation of a FID that does not have "self diagnostic reporting" functionality when outdoor air temperature is less than 55F~~
- ~~RA3.4.2.3 Verification of Installation of a FID when the outdoor air temperature is equal to or greater than 55F~~

RA[NEW] Simplifying Load Calculation Input Assumptions

Under circumstances described in 150.0(h)1iv, the following simplified load calculation input assumptions may be made.

	<u>Sub-category</u>	<u>Simplification*</u>	<u>Notes</u>		<u>Sub-category</u>	<u>Simplification*</u>	<u>Notes</u>
<u>General</u>	<u>floor area</u>	<u>actual ± 5%</u>	<u>can simplify perimeter footprint</u>		<u>#bedrooms</u>	<u>actual</u>	
	<u>block load</u>	<u>"Yes"</u>	<u>room by room not required</u>		<u>ventilation</u>	<u>ASHRAE 62.2, exhaust only</u>	
	<u>design temps.</u>	<u>code required</u>			<u>occupants</u>	<u># of bedrooms + 1</u>	
	<u>infiltration</u>	<u>"Average"</u>					
<u>Windows</u>	<u>area</u>	<u>actual</u>	<u>combined into one per direction</u>		<u># panes</u>	<u>actual</u>	
	<u>direction</u>	<u>actual</u>	<u>round to nearest 45 deg</u>		<u>frame type</u>	<u>actual</u>	<u>use predominant, if multiple</u>
	<u>tilt</u>	<u>"Vertical" for windows</u>			<u>exterior shade</u>	<u>ignore</u>	
	<u>overhangs</u>	<u>ignore unless > 1:1; on S/SW side</u>	<u>model if extension is greater than height above window</u>		<u>storm</u>	<u>ignore</u>	
	<u>U factor</u>	<u>default table</u>	<u>table 110.6-A</u>		<u>impact</u>	<u>ignore</u>	
	<u>SHGC</u>	<u>default table</u>	<u>table 110.6-B</u>		<u>structural</u>	<u>ignore</u>	
	<u>interior shade</u>	<u>"Closed Drapes"</u>			<u>skylight curb</u>	<u>ignore</u>	
	<u>tint</u>	<u>"Clear"</u>					
<u>Doors</u>	<u>area</u>	<u>actual</u>			<u>U factor</u>	<u>"Solid Wood"</u>	
<u>Floors</u>	<u>area/ slab</u>	<u>actual ± 10%</u>			<u>framing fraction</u>	<u>"15%"</u>	
	<u>type</u>	<u>actual</u>	<u>raised, slab, etc.</u>		<u>crawlspace wall R</u>	<u>vintage table</u>	<u>Table R3-50**</u>
	<u>covering</u>	<u>"100% Carpet"</u>			<u>crawlspace vented?</u>	<u>"Yes"</u>	
	<u>R-value</u>	<u>vintage table</u>	<u>Table R3-50**</u>		<u>crawlspace cond'd?</u>	<u>"No"</u>	
<u>Walls</u>	<u>area</u>	<u>actual ± 10%</u>	<u>avg height for vaulted ceilings</u>		<u>sheathing R value</u>	<u>vintage table</u>	<u>Table R3-50**</u>
	<u>type</u>	<u>actual</u>	<u>wood frame, brick, etc.</u>		<u>framing factor</u>	<u>"15%"</u>	
	<u>cavity R value</u>	<u>vintage table</u>	<u>Table R3-50**</u>				
<u>Ceiling</u>	<u>area</u>	<u>actual ± 10%</u>			<u>R value</u>	<u>vintage</u>	<u>Table R3-50**</u>
	<u>type</u>	<u>actual</u>	<u>below attic, cathedral, etc.</u>		<u>framing factor</u>	<u>"15%"</u>	
	<u>insulation type</u>	<u>"Fiberglass Batt"</u>			<u>truss type</u>	<u>"Wood"</u>	
<u>Roof</u>	<u>type</u>	<u>"Tile"</u>			<u>framing fraction</u>	<u>"15%"</u>	
	<u>attic?</u>	<u>"Yes"</u>			<u>radiant barrier?</u>	<u>"No"</u>	
	<u>color</u>	<u>"Dark"</u>			<u>vented</u>	<u>"Yes"</u>	
	<u>config.</u>	<u>actual</u>	<u>attic, cathedral, etc.</u>		<u>tile</u>	<u>4:12</u>	

	<u>deck insulation</u>	<u>"No"</u>		<u>cool roof</u>	<u>"No"</u>	
	<u>absorption</u>	<u>use default</u>				
<u>Ducts</u>	<u>R value</u>	<u>vintage table</u>	<u>Table R3-50**</u>	<u>leakage</u>	<u>10% total</u>	
	<u>location</u>	<u>actual</u>	<u>attic crawlspace etc.</u>			

* All simplifications are "unless documented otherwise"

**See [2016 Residential Compliance Manual Appendix B](#) or [2016 Residential ACM Manual](#)