RED1-285-22 – AS MODIFIED IN BLUE SINCE APPROVED BY RES HVACR-WH SUBCOMMITTEE

IECC: SECTION 202 (New), SECTION 202, R401.3, R402.2.9, TABLE R402.5.1.1, SECTION R403, R403.3, R403.3.1, R403.3.2, R403.3.3, R403.3.3.1, R403.3.4, R403.3.4.1, R403.3.5, R403.3.6, TABLE R403.3.6, R403.3.7, R403.3.8, TABLE R403.6.2, SECTION R405, R405.3.2.1, TABLE R405.4.2(1), TABLE R405.4.2(2), SECTION R408, TABLE R408.2, R408.2.4, SECTION R502, R502.2.2, SECTION R503, R503.1.2, R503.1.2.1, R503.1.2.3

Proponents: Gary Klein, representing Self (gary@garykleinassociates.com); Mark Lyles, representing California IOUs (markl@newbuildings.org); Gayathri Vijayakumar, representing Steven Winter Associates, Inc. (gvijayakumar@swinter.com)

2024 International Energy Conservation Code [RE Project]

Add new definition as follows:

AIR-HANDLING UNIT. A blower or fan used for the purpose of distributing supply air to a room, space or area.

Revise as follows:

CONDITIONED SPACE. An area, room or space that is enclosed within the *building thermal envelope* and is directly or indirectly heated or cooled. Spaces are indirectly heated or cooled where they communicate through openings with conditioned spaces, where they are separated from conditioned spaces by uninsulated walls, floors or ceilings, or where they contain uninsulated ~~ducts~~ *ducts*, piping or other sources of heating or cooling.

Add new definition as follows:

DAMPER. A manually or automatically controlled device to regulate draft or the rate of flow of air or combustion gases.

Revise as follows:

DUCT SYSTEM. ~~A continuous passageway for the transmission of air that, in addition to ducts, includes duct fittings, dampers, plenums, fans and accessory air-handling equipment and appliances~~ A system that consists of *space conditioning equipment*, *ductwork*, and ~~shall include~~ includes any apparatus installed in connection therewith.

Add new definition as follows:

DUCTWORK. The assemblies of connected *ducts*, *plenums*, boots, fittings, *dampers*, supply registers, return grilles, and filter grilles through which air is supplied to or returned from the space to be heated, ~~or~~ cooled, or ventilated. Supply ductwork delivers air to the spaces from the *space conditioning equipment*. Return ductwork conveys air from the spaces back to the *space conditioning equipment*. Ventilation ductwork conveys air to or from any space.

HEAT EXCHANGER. A device that transfers heat from one medium to another.

OCCUPIABLE SPACE. An enclosed space intended for human activities, excluding those spaces intended primarily for other purposes, such as storage rooms and equipment rooms, that are only intended to be occupied occasionally and for short periods of time.

PLENUM. An enclosed portion of the building structure, other than an *occupiable space* being conditioned, that is designed to allow air movement, and thereby serve as part of the supply or return *ductwork*.

SPACE CONDITIONING. The treatment of air so as to control simultaneously the temperature, humidity, ~~cleanness~~ filtration, and distribution of the air to meet the requirements of a conditioned space.

SPACE CONDITIONING EQUIPMENT. The *heat exchangers*, *air-handling units*, filter boxes, and any apparatus installed in connection therewith used to provide *space conditioning*.

Revise as follows:

R401.3 Certificate. A permanent certificate shall be completed by the builder or other *approved* party and posted on a wall in the space where the furnace is located, a utility room or an *approved* location inside the *building*. Where located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory *label*, service disconnect *label* or other required labels. The certificate shall indicate the following:

1. The predominant *R*-values of insulation installed in or on ceilings, roofs, walls, foundation components such as slabs, *basement walls*, *crawl space walls* and floors and *ducts* ~~ducts~~ outside *conditioned spaces*.
2. *U*-factors of fenestration and the *solar heat gain coefficient* (SHGC) of fenestration. Where there is more than one value for any component of the building envelope, the certificate shall indicate both the value covering the largest area and the area weighted average value if available.
3. The results from any required *duct system* ~~duct system~~ and building envelope air leakage testing performed on the building.
4. The types, sizes and efficiencies of heating, cooling and service water-heating equipment. Where a gas-fired unvented room heater, electric furnace or baseboard electric heater is installed in the residence, the certificate shall indicate “gas-fired unvented room heater,” “electric furnace” or “baseboard electric heater,” as appropriate. An efficiency shall not be indicated for gas-fired unvented room heaters, electric furnaces and electric baseboard heaters.
5. Where on-site *photovoltaic panel* systems have been installed, the array capacity, inverter efficiency, panel tilt and orientation shall be noted on the certificate.

6. For buildings where an Energy Rating Index score is determined in accordance with Section R406, the Energy Rating Index score, both with and without any on-site generation, shall be listed on the certificate.
7. The code edition under which the structure was permitted, the compliance path used, and where applicable, the additional efficiency measures selected for compliance with R408.
8. Where a solar-ready zone is provided, the certificate shall indicate the location, and dimensions.

R402.2.9 Basement walls. Basement walls shall be insulated in accordance with Table R402.1.3.

Exception: Basement walls associated with unconditioned basements where ~~all of~~ the following requirements are met:

1. The floor overhead, including the underside stairway stringer leading to the basement, is insulated in accordance with Section R402.1.3 and applicable provisions of Sections R402.2 and R402.2.8.
2. There are no uninsulated ~~duct~~ *ductwork*, domestic hot water piping, or hydronic heating surfaces exposed to the basement.
3. There are no HVAC supply or return diffusers serving the basement.
4. The walls surrounding the stairway and adjacent to *conditioned space* are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2.
5. The door(s) leading to the basement from *conditioned spaces* are insulated in accordance with Section R402.1.3 and applicable provisions of Section R402.2, and weatherstripped in accordance with Section R402.5.
6. The building thermal envelope separating the basement from adjacent *conditioned spaces* complies with Section R402.5.

TABLE R402.5.1.1 AIR BARRIER, AIR SEALING AND INSULATION INSTALLATION[a]

Portions of table not shown remain unchanged.

COMPONENT	AIR BARRIER CRITERIA	INSULATION INSTALLATION CRITERIA
Shafts, penetrations	*Duct* ~~Duct~~ and flue shafts to exterior or unconditioned space shall be sealed. Utility penetrations of the air barrier shall be caulked, gasketed or otherwise sealed and shall allow for expansion, contraction of materials and mechanical vibration.	Insulation shall be fitted tightly around utilities passing through shafts and penetrations in the building thermal envelope to maintain required *R*-value.
Recessed lighting	Recessed light fixtures installed in the building thermal envelope shall be air sealed in accordance with Section R402.5.5.	Recessed light fixtures installed in the building thermal envelope shall be airtight and IC rated, and shall be buried in or surrounded with insulation.
Electrical,communication, and other equipment boxes, housings, and enclosures	Boxes, housing, and enclosures that penetrate the air barrier shall be caulked, taped, gasketed, or otherwise sealed to the air barrier element being penetrated. All concealed openings into the box, housing, or enclosure shall be sealed. The continuity of the air barrier shall be maintained around boxes, housings, and enclosures that penetrate the air barrier. Alternatively, air-sealed boxes shall be installed in accordance with R402.5.6.	Boxes, housing, and enclosures shall be ~~burried~~ buried in or surrounded by insulation.
HVAC register boots	HVAC supply and return register boots ~~that penetrate building thermal envelope~~ shall be sealed to the subfloor, wall covering or ceiling penetrated by the boot.	HVAC supply and return register boots located ~~in~~ within a ~~the building's thermal envelope~~ *building thermal envelope* assembly shall be buried ~~burried~~ in or ~~and~~ surrounded by insulation.

a. Inspection of log walls shall be in accordance with the provisions of ICC 400.

b. Insulation full enclosure is not required in unconditioned/ventilated attic spaces and at rim joists.

SECTION R403
SYSTEMS

Revise as follows:

R403.3 Duct systems. ~~Ducts and air handlers~~ *Duct systems* shall be installed in accordance with Sections R403.3.1 through R403.3.~~8~~7~~9~~.

Exception: *Ducts* ~~serving ventilation systems~~ Ventilation *ductwork* that is ~~are~~ not integrated with *duct systems* serving heating or cooling systems.

R403.3.1 ~~Ducts~~ Ductwork located outside conditioned space. Supply and return *ductwork* ~~*ducts*~~ located outside *conditioned space* shall be insulated to an *R*-value of not less than R-8 for *ducts* 3 inches (76 mm) in diameter and larger and not less than R-6 for *ducts* smaller than 3 inches (76 mm) in diameter. *Ductwork* ~~*Ducts*~~ buried beneath a building shall be insulated as required per this section or have an equivalent *thermal distribution efficiency*. Underground *ductwork* ~~*ducts*~~ utilizing the *thermal distribution efficiency* method shall be listed and *labeled* to indicate the *R*- value equivalency.

R403.3.2 Ducts systems located in conditioned space. For ~~ductwork~~ *duct systems* to be considered inside a *conditioned space,* the *space conditioning equipment* shall be located completely ~~within the *continuous air barrier* and within~~ on the conditioned side of the *building thermal envelope*. The *ductwork* ~~it~~ shall comply with ~~one of~~ the following as applicable:

1. The ~~duct system~~ *ductwork* shall be located completely ~~within the *continuous air barrier* and within~~ on the conditioned side of the *building thermal envelope.*
2. *Ductwork* ~~Ductwork~~ in ventilated attic spaces or unvented attics with vapor diffusion ports shall be buried within ceiling insulation in accordance with Section R403.3.3 and ~~all of~~ shall comply with the following ~~conditions shall exist~~:

   ~~2.1. The air handler is located completely within the *continuous air barrier* and within the *building thermal envelope.*~~

   2.21. The ~~duct~~ *ductwork* leakage, as measured either by a rough-in test of the supply and return ~~ducts~~ *ductwork* or a post-construction ~~total~~ *duct system* leakage test to outside the *building thermal envelope* in accordance with Section R403.3. ~~5~~6, ~~is less than or equal to~~ is not greater than 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area* served by the *duct system*.

   2.32. The ceiling insulation *R*-value installed against and above the insulated ~~duct~~ *ductwork* is greater than or equal to the proposed ceiling insulation *R*-value, less the *R*-value of the insulation on the ~~duct~~ *ductwork*.

3. *Ductwork* ~~located in~~ contained within wall or floor ~~building~~ assemblies separating unconditioned from conditioned space shall comply with the following:

~~3.1.~~ A *continuous air barrier* shall be installed as part of the building assembly between the ~~duct~~ *ductwork* and the unconditioned space.

~~3.2. Ducts~~ *Ductwork* shall be installed in accordance with Section R403.3.1.

Exception: Where the building assembly cavities containing ~~ducts~~ *ductwork* have been air sealed in accordance with Section R402.5.1, duct insulation is not required.

~~3.3.~~ Not less than R-10 ~~assembly~~ insulation, ~~and~~ or not less than 50 percent of the ~~assembly~~ ~~insulation~~ required insulation R-value specified in Table R402.1.3, whichever is greater, shall be located between the ~~duct~~ *ductwork* and the unconditioned space.

~~3.4 For ducts in these building assemblies to be considered within conditioned space, the air handling equipment shall be installed within conditioned space.~~

Segments of *ductwork* contained within ~~these~~ such building assemblies shall not be considered completely inside *conditioned space* ~~in~~ for compliance with Sections R405 or R406.

R403.3.3 Ductwork ~~Ducts~~ buried within ceiling insulation. Where supply and return *ductwork* ~~air ducts~~ ~~are~~ is partially or completely buried in ceiling insulation, such *ductwork* ~~ducts~~ shall comply with ~~all of~~ the following:

1. The supply and return ~~ducts~~ *ductwork* shall be insulated with ~~have an insulation *R*-value~~ not less than R-8 insulation.
2. At all points along ~~each duct~~ the *ductwork*, the sum of the ceiling insulation *R*-value against and above the top of the ~~duct~~ *ductwork*, and against and below the bottom of the ~~duct~~ *ductwork*, shall be not less than R-19, excluding the *R*-value of the duct insulation.
3. In Climate Zones 0A, 1A, 2A and 3A, the supply ~~ducts~~ *ductwork* shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-13 and in compliance with the vapor retarder requirements of Section 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable**.**

   Exception: Sections of the supply ~~ducts~~ *ductwork* that are less than 3 feet (914 mm) from the supply outlet ~~shall not be required to comply with these requirements~~.

4. In Climate Zones 0A, 1A, 2A and 3A ~~when~~ where installed in an unvented attic with vapor diffusion ports, the supply ~~ducts~~ *ductwork* shall be completely buried within ceiling insulation, insulated to an *R*-value of not less than R-8 and in compliance with the vapor retarder requirements of Section 604.11 of the *International Mechanical Code* or Section M1601.4.6 of the *International Residential Code*, as applicable.

   Exception: Sections of the supply ~~ducts~~ *ductwork* duct that are less than 3 feet (914 mm) from the supply outlet ~~shall not be required to comply with these requirements~~.

4.1 Air permeable insulation installed in unvented attics shall ~~be in compliance~~ comply with ~~the requirements of~~ Section R806.5.5.2 of the *International Residential Code*.

R403.3.3.1 Effective R-value of deeply buried ducts. Where ~~complying using Section R405, the Building Simulated Performance Compliance Option in accordance with Section R401.2.2,~~ sections of ~~ducts~~ *ductwork* that are installed in accordance with Section R403.3.3 surrounded with blown-in attic insulation having an *R*-value of R-30 or greater, and located such that the top of the ~~duct~~ *ductwork* is not less than 3.5 inches (89 mm) below the top of the insulation, shall be considered as having an effective duct insulation *R*-value of R-25.

R403.3.4 Sealing. ~~Ducts, air handlers~~ *Ductwork*, *air-handling units* and filter boxes shall be sealed. Joints and seams shall comply with ~~either~~ the International Mechanical Code or the International Residential Code, as applicable.

R403.3.4.1 Sealed ~~air handler~~ air-handling unit. ~~Air~~ ~~handlers~~*Air-handling units* shall have a manufacturer's designation for an air leakage ~~of~~ not greater than 2 percent of the design airflow rate when tested in accordance with ASHRAE 193.

R403.3.5 Duct system testing. Each *duct system* ~~ducts system~~ shall be tested for air leakage in accordance with ANSI/RESNET/ICC 380 or ASTM E1554. Total leakage shall be measured with a pressure differential of 0.1 inch water gauge ~~w.g.~~(25 Pa) across the ~~system~~ *duct system* and shall include the measured leakage from ~~both~~ the supply and return *ductwork*. ~~Registers shall be sealed during the test.~~ A written report of the test results shall be signed by the party conducting the test and provided to the *code official*. *Duct system* ~~Duct system~~ leakage testing at either rough-in or post-construction shall be permitted with or without the installation of registers or grilles. Where installed, registers and grilles shall be ~~temporarily~~ sealed during the test. Where registers and grilles are not installed, the face of the register boots shall be ~~temporarily~~ sealed during the test.

Exceptions:

1. Testing shall not be required for *duct systems* ~~duct systems~~ serving ventilation systems that are not integrated with *duct systems* ~~duct systems~~ serving heating or cooling systems.
2. Testing shall not be required where there is not more than 10 feet of total *ductwork* external to the *space conditioning equipment* and both the following are met :

   a. The *duct system* is located entirely within *conditioned space* .

b. The *ductwork* does not include *plenums* constructed of building cavities or ~~sheetrock~~ gypsum board.

3. Where the *space conditioning equipment* is not installed, testing shall be permitted. The total measured leakage of the supply and return *ductwork* shall be less than or equal to 3.0 cubic feet per minute (85 L/min) per 100 square feet (9.29 m^2) of *conditioned floor area.*

~~2~~ 4. Where tested in accordance with Section R403.3.7, testing of each *duct system* ~~duct system~~ is not required.

R403.3.6 Duct system leakage. The total measured ~~duct system~~ *duct system* leakage shall not be greater than the values in Table R403.3.6, based on the conditioned floor area, number of ducted returns, and location of the *duct system.* For buildings complying with Section R405 or R406, where ~~duct system~~ *duct system* ~~duct system~~ leakage to outside is tested in accordance with ANSI/RESNET/ICC 380 or ASTM E1554, the leakage to outside value shall not be used for compliance with this section, but shall be permitted to be used in the calculation procedures of Section R405 and R406.

TABLE R403.3.6 MAXIMUM TOTAL DUCT SYSTEM LEAKAGE

~~ROUGH IN~~	~~POST CONSTRUCTION~~	
~~Duct systems serving more than 1,000 ft^2 of conditioned floor area~~	~~cfm/100 ft^2 (LPM/9.29 m^2)~~	~~cfm/100 ft^2 (LPM/9.29 m^2)~~
~~Air handler is not installed~~	~~3 (85)~~	~~NA~~
~~Air handler is installed~~	~~4 (113.3)~~	~~4 (113.3)~~
~~Duct systems located in conditioned space, with air handler installed~~	~~8 (226.6)~~	~~8 (226.6)~~
~~Duct systems serving less than or equal to 1,000 ft^2 of conditioned floor area~~	~~cfm (LPM)~~	~~cfm (LPM)~~
~~Air handler is not installed~~	~~30 (849.5)~~	~~NA~~
~~Air handler is installed~~	~~40 (1132.7)~~	~~40 (1132.7)~~
~~Duct systems located in conditioned space, with air handler installed~~	~~80 (2265.4)~~	~~80 (2265.4)~~

	***Duct systems* serving more than 1,000 ft² of conditioned floor area**		***Duct systems* serving ~~less than or equal to~~ 1,000 ft² or less of conditioned floor area**
	cfm/100 ft² (LPM/9.29 m²)		cfm (LPM)
	Number of ducted returns [a]		
	< 3	≥ 3	Any
Space conditioning equipment is not installed [b, ~~c~~]	3 (85)	4 (113~~.3~~)	30 (850 ~~849.5~~)
All components of the *duct system* are installed	4 (113~~.3~~)	6 (170)	40 (11332~~.7~~)
~~*Space conditioning equipment* is not installed, but the~~ *ductwork* is located entirely in *conditioned space*[~~cd~~]	6 (170)	8(227)	60 (1699)
All components of the *duct system* are installed and entirely located in *conditioned space*[c]	8 (22~~76.6~~)	12(340)	80 2265~~.4~~)

a. A ducted return is a *duct* made of sheet metal or flexible *duct* that connects one or more return grilles to the return-side inlet of the *air-handling unit*. Any other ~~approach~~ method to convey air from return or transfer grille(s) to the *air-handling unit* does not constitute a ducted return for the purpose of determining maximum total *duct system* leakage allowance.

b. ~~Where the *space conditioning equipment* is not installed, *duct system* testing shall be permitted and shall include the measured leakage from both the supply and return *ductwork*. *Duct system* testing shall not be performed if the return *ductwork* is not installed.~~ *Duct system* testing is permitted where *space conditioning equipment* is not installed, provided the return *ductwork* is installed, and the measured leakage from the supply and return ductwork is included.

c. For *duct systems* to be considered inside a *conditioned space*, where the *ductwork* is located in ventilated attic spaces or unvented attics with vapor diffusion ports, *duct system* leakage to outside ~~shall~~ must comply with Item 2.1 of Section R403.3.2. ~~be measured in accordance with ANSI/RESNET/ICC 380 or ASTM E1554 and shall be less than or equal to 1.5 cubic feet per minute (42.5 L/min) per 100 square feet (9.29 m²) of *conditioned floor area* served by the *duct system*~~.

d. Prior to certificate of occupancy, where the *air-handling unit* is not verified as being located in ~~*un*~~*conditioned space*, the total *duct system* leakage must be re-tested.

R403.3.7 Dwelling unit sampling. For buildings with eight or more *dwelling units* the duct systems in the greater of seven, or 20 percent of the *dwelling units* in the building shall be tested, including a top floor unit, a ground floor unit, a middle floor unit, and the unit with the largest conditioned floor area. Where buildings have fewer than eight *dwelling units*, the duct systems in each unit shall be tested. Where the leakage ~~rate~~ of a *duct system* is greater than the maximum permitted *duct system* leakage ~~rate~~, corrective actions shall be made to the *duct system* ~~system~~ and the *duct system* shall be retested until it passes. For each tested *dwelling unit* that has a greater total *duct system* leakage ~~rate~~ than the maximum permitted *duct system* leakage ~~rate~~, an additional three *dwelling units*, including the corrected unit, shall be tested.

~~R403~~.3.~~8~~2 **Building cavities.** *Building* framing cavities shall not be used as ~~ducts~~ *ductwork* or *plenums*.

R403.3.1 Duct System Design. *Duct systems* serving one or two *dwelling units* shall be designed and sized in accordance with ANSI/ACCA Manual D. *Duct systems* serving more than two *dwelling units* shall be sized in accordance with the ASHRAE Handbook of Fundamentals, ANSI/ACCA Manual D, or other equivalent computation procedure.

TABLE R403.6.2 WHOLE-DWELLING MECHANICAL VENTILATION SYSTEM FAN EFFICACY[a]
Portions of table not shown remain unchanged.

SYSTEM TYPE	AIRFLOW RATE (CFM)	MINIMUM EFFICACY (CFM/WATT)	TEST PROCEDURE
~~Air-handler~~ *Air-handling unit* that is integrated to tested and *listed* HVAC equipment	Any	1.2	Outdoor airflow as specified. *Air-handling unit* ~~Air-handler~~ fan power determined in accordance with the HVAC appliance's test method referenced by Section C403.3.2 of the IECC-Commercial Provisions.

For SI: 1 cubic foot per minute = 0.47 L/s.

a. Design outdoor airflow rate/watts of fan used.

SECTION R405
SIMULATED BUILDING PERFORMANCE

Revise as follows:

R405.3.2.1 Compliance report for permit application. A compliance report submitted with the application for building permit shall include the following:

1. Building street address, or other *building site* identification.
2. The name of the individual performing the analysis and generating the compliance report.
3. The name and version of the compliance software tool.
4. Documentation of all inputs ~~entered into~~ to the software used to produce the results for the reference design ~~and/~~or the rated home.
5. A certificate indicating that the proposed design complies with Section R405.3. The certificate shall document the building components' energy specifications that are included in the calculation including: component-level insulation *R*-values or *U*-factors; ~~duct system~~ *duct system* and building envelope air leakage testing assumptions; and the type and rated efficiencies of proposed heating, cooling, mechanical ventilation and service water-heating equipment to be installed. If on-site renewable energy systems will be installed, the certificate shall report the type and production size of the proposed system.
6. Where a site-specific report is not generated, the proposed design shall be based on the worst-case orientation and configuration of the rated home.

TABLE R405.4.2(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

<table>
<tr><th>BUILDING COMPONENT</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td></td><td>Duct location</td><td>Duct location: as proposed</td></tr>
<tr><td></td><td>
<table>
<tr><td>Foundation type</td><td>Slab on grade</td><td>Unconditioned crawl space</td><td>Basement or conditioned crawl space</td></tr>
<tr><td>Duct location (supply and return)</td><td>One-story building: 100% in unconditioned attic

All other: 75% in unconditioned attic and 25% inside conditioned space</td><td>One-story building: 100% in unconditioned crawl space

All other: 75% in unconditioned crawlspace and 25% inside conditioned space</td><td>~~75~~50% inside conditioned space

~~25~~50% unconditioned attic</td></tr>
</table>
</td><td></td></tr>
<tr><td></td><td>Duct Insulation: in accordance with Section R403.3.1</td><td>Duct Insulation: as proposed</td></tr>
<tr><td rowspan="2">Thermal distribution systems</td><td>~~Duct system~~ Duct system leakage to outside:
For duct systems serving > 1,000ft^2 of conditioned floor area, the duct leakage to outside rate shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area.
For duct systems serving ≤ 1,000ft^2 of conditioned floor area, the duct leakage to outside rate shall be 40 cfm (1132.7 L/min).</td><td>Duct System Leakage to Outside: The measured total duct system leakage rate shall be entered into the software as the duct system leakage to outside rate.
Exceptions:
<table>
<tr><td>1.</td><td>~~When~~ Where duct system leakage to outside is tested in accordance ANSI/ RESNET/ICC 380 or ASTM E1554, the measured value shall be permitted to be entered.</td></tr>
<tr><td>2.</td><td>~~When~~ Where total duct system leakage is measured without the space conditioning equipment ~~air handler~~ installed, the simulation value shall be 4 cfm (113.3 L/min) per 100 ft^2 (9.29 m^2) of conditioned floor area.</td></tr>
</table>
</td></tr>
<tr><td>Distribution System Efficiency (DSE):

For hydronic systems and ductless systems a thermal distribution system efficiency (DSE) of 0.88 shall be applied to both the heating and cooling system efficiencies.</td><td>Distribution System Efficiency (DSE):

For hydronic systems and ductless systems, DSE shall be as specified in Table R405.4.2(2).</td></tr>
</table>

For SI: 1 square foot = 0.93 m^2, 1 British thermal unit = 1055 J, 1 pound per square foot = 4.88 kg/m^2, 1 gallon (US) = 3.785 L, °C = (°F-32)/1.8, 1 degree = 0.79 rad.

a. Where required by the code official, testing shall be conducted by an approved party. Hourly calculations as specified in the ASHRAE *Handbook of Fundamentals,* or the equivalent, shall be used to determine the energy loads resulting from infiltration.

b. The combined air exchange rate for infiltration and mechanical ventilation shall be determined in accordance with Equation 43 of 2001 ASHRAE *Handbook of Fundamentals,* page 26.24 and the "Whole-house Ventilation" provisions of 2001 ASHRAE *Handbook of Fundamentals,* page 26.19 for intermittent mechanical ventilation.

c. Thermal storage element shall mean a component that is not part of the floors, walls or ceilings that is part of a passive solar system, and that

provides thermal storage such as enclosed water columns, rock beds, or phase-change containers. A thermal storage element shall be in the same room as fenestration that faces within 15 degrees (0.26 rad) of true south, or shall be connected to such a room with pipes or ducts that allow the element to be actively charged.

d. For a proposed design with multiple heating, cooling or water heating systems using different fuel types, the applicable standard reference design system capacities and fuel types shall be weighted in accordance with their respective loads as calculated by accepted engineering practice for each equipment and fuel type present.

e. For a proposed design without a proposed heating system, a heating system having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and proposed design.

f. For a proposed design home without a proposed cooling system, an electric air conditioner having the prevailing federal minimum efficiency shall be assumed for both the standard reference design and the proposed design.

g. For a proposed design the following assumptions shall be made for both the proposed design and standard reference design.

Fuel Type: Same as the predominant heating fuel type Rated

Storage Volume: 40 Gallons

Draw Pattern: Medium

Efficiency: Uniform Energy Factor complying with 10 CFR §130.32

h. For residences with conditioned basements, R-2 and R-4 residences, and for townhouse units, the following formula shall be used to determine glazing area:

AF $= A_s \times FA \times F$

where:

AF	= Total glazing area.
A_s	= Standard reference design total glazing area.
FA	= (Above-grade thermal boundary gross wall area)/(above-grade boundary wall area + 0.5 × below-grade boundary wall area).
F	= (above-grade thermal boundary wall area)/(above-grade thermal boundary wall area + common wall area) or 0.56, whichever is greater.

and where:

-	Thermal boundary wall is any wall that separates *conditioned space* from unconditioned space or ambient conditions.
-	Above-grade thermal boundary wall is any thermal boundary wall component not in contact with soil.
-	Below-grade boundary wall is any thermal boundary wall in soil contact.

- Common wall area is the area of walls shared with an adjoining dwelling unit.

i. The factor for the compactness of the hot water distribution system is the ratio of the area of the rectangle that bounds the source of hot water and the fixtures that it serves (the "hot water rectangle") divided by the floor area of the dwelling.

1. Sources of hot water include water heaters, or in multiple-family buildings with central water heating systems, circulation loops or electric heat traced pipes.
2. The hot water rectangle shall include the source of hot water and the points of termination of all hot water fixture supply piping.
3. The hot water rectangle shall be shown on the floor plans and the area shall be computed to the nearest square foot.
4. Where there is more than one water heater and each water heater serves different plumbing fixtures and appliances, it is permissible to establish a separate hot water rectangle for each hot water distribution system and add the area of these rectangles together to determine the compactness ratio.
5. The basement or attic shall be counted as a story when it contains the water heater.
6. Compliance shall be demonstrated by providing a drawing on the plans that shows the hot water distribution system rectangle(s), comparing the area of the rectangle(s) to the area of the dwelling and identifying the appropriate compactness ratio and *HWDS* factor.

j. For a proposed design with electric resistance heating, a split system heat pump complying with 10 CFR §430.32 (2021) shall be assumed modeled in the standard reference design.

k. For heating systems, cooling systems, or water heating systems not included in Table R405.4.2(1), the standard reference design shall be the same as proposed design.

l. Only sections of *ductwork* that are installed in accordance with Items 1 or 2 of Section R403.3.2, ~~shall~~ are ~~be~~ assumed to be located completely inside *conditioned space*. All other sections of *ductwork* ~~shall~~ are not ~~be~~ assumed to be located completely inside *conditioned space*.

m. Sections of *ductwork* installed in accordance with Section R403.3.3.1, ~~shall~~ are ~~be~~ assumed to have an effective duct insulation R-value of R-25.

TABLE R405.4.2(2) DEFAULT DISTRIBUTION SYSTEM EFFICIENCIES FOR PROPOSED DESIGNS[a]

DISTRIBUTION SYSTEM CONFIGURATION AND CONDITION	FORCED AIR SYSTEMS	HYDRONIC SYSTEMS[b]
Distribution system components located in unconditioned space	NA	0.95
Distribution system components entirely located in *conditioned space*[c]	NA	1
"Ductless" systems[d]	1	NA

a. Default values in this table are for untested distribution systems, which must still ~~meet minimum requirements from~~ form ~~comply with~~ Section R403 ~~for duct system insulation~~.

b. Hydronic systems ~~shall~~ means those systems that distribute heating and cooling energy directly to individual spaces using liquids pumped through closed-loop piping and that do not depend on ducted, forced airflow to maintain space temperatures.

c. Entire system in *conditioned space* ~~shall~~ means that no component of the distribution system, ~~including the air-handling unit,~~ is located outside of the *conditioned space*.

d. Ductless systems ~~shall be~~ are allowed to have forced airflow across a coil but ~~shall~~ must not have greater than 10 ft. of ~~any~~ ducted airflow external to the ~~manufacturer's air-handler enclosure~~ *space conditioning equipment*.

SECTION R408
ADDITIONAL EFFICIENCY REQUIREMENTS

Revise as follows:

TABLE R408.2 CREDITS FOR ADDITIONAL ENERGY EFFICIENCY

Portions of table not shown remain unchanged.

Measure Number	Measure Description	Credit Value								
		Climate Zone 0 & 1	Climate Zone 2	Climate Zone 3	Climate Zone 4	Climate Zone 4C	Climate Zone 5	Climate Zone 6	Climate Zone 7	Climate Zone 8
R408.2.4(2)	100% of *duct systems* ~~ducts~~ in *conditioned space*	4	6	8	12	12	15	17	19	20
R408.2.4(3)	≥ 80% of *ductwork* inside *conditioned space*	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
R408.2.4(~~43~~)	Reduced total duct leakage	1	1	1	1	1	1	2	2	2

R408.2.4 More efficient ~~duct~~ thermal distribution system option. The thermal distribution system shall ~~meet one of the~~ comply with one of the following ~~efficiencies~~:

1. ~~100 percent of~~ The ductless thermal distribution system or hydronic thermal distribution system is located completely ~~inside~~ on the conditioned side of the *building thermal envelope*.
2. ~~100 percent of t~~The The *space conditioning equipment* is located inside *conditioned space*. In addition, 100 percent of the *ductwork* ~~*system* thermal distribution system~~ is located completely inside *conditioned space* as defined by item 1 and item 2 of Section R403.3.2.
3. The *space conditioning equipment* is located inside *conditioned space* and no less than 80 percent of *ductwork* is located completely inside *conditioned space* as defined by item 1 and item 2 of Section R403.3.2. In addition, no more than 20 percent of *ductwork* is contained within building assemblies separating unconditioned from *conditioned space* as defined by item 3 of Section R403.3.2.
4. ~~When~~ Where ~~ducts are~~ *ductwork* is located outside *conditioned space*, the total leakage ~~of the ducts,~~ of the *duct system* measured in accordance with R403.3.5, ~~shall be in accordance with~~ is one of the following:

   4.1 Where the *space conditioning equipment* ~~air handler~~ is installed at the time of testing, total leakage is not greater than 2.0 cubic feet per minute (0.94 L/s) per 100 square feet (9.29 m^2) of conditioned floor area.

   4.2 Where the *space conditioning equipment* ~~air handler~~ is not installed at the time of testing, total leakage is not greater than 1.75 cubic feet per minute (0.83 L/s) per 100 square feet (9.29 m^2) of conditioned floor area.

SECTION R502
ADDITIONS

Revise as follows:

R502.2.2 Heating and cooling systems. HVAC *ductwork* ~~ducts~~ newly installed as part of an *addition* shall comply with Section R403.

Exception: Where *ductwork* ~~ducts~~ from an existing heating and cooling system ~~are~~ is extended into an *addition* Section R403.3.5 and Section R403.3.6 shall not be required.

SECTION R503
ALTERATIONS

Revise as follows:

R503.1.2 Heating and cooling systems. New heating and cooling systems and *ductwork* ~~duct systems~~ that are part of the alteration shall comply with Section R403 and this section . Alterations to existing heating and, cooling systems ~~and~~ *ductwork* ~~duct systems~~ shall comply with this section.

Exception: Where *ductwork* ~~ducts~~ from an existing heating and cooling system ~~are~~ is extended to an *addition*.

R503.1.2.1 ~~Ducts~~ *Ductwork*. HVAC *ductwork* ~~ducts~~ newly installed as part of an alteration shall comply with Section R403.

Exception: Where *ductwork* ~~ducts~~ from an existing heating and cooling system ~~are~~ is extended to an *addition*.

R503.1.2.3 Duct system leakage. Where an *alteration* includes any of the following, *duct systems* ~~ducts~~ shall be tested in accordance with Section R403.3.5 and shall have a total leakage less than or equal to 12.0 cubic feet per minute (339.9 L/min) per 100 square feet (9.29 m^2) of conditioned floor area:

1. Where 25 percent or more of the registers that are part of the duct system are relocated.
2. Where 25 percent or more of the total length of all *ductwork* ~~ducts~~ in the *duct system* are relocated.
3. Where the total length of all *ductwork* ~~ducts~~ in the *duct system* is increased by 25 percent or more.

Exception: *Duct systems* located entirely inside a *conditioned space* in accordance with Section R403.3.2.

Reason: This public comment is being submitted to achieve the following:

- **Better define what the code means when it says "ducts", "ductwork", and "duct system", by using 2021 IMC definitions, modified as needed.**
- **Use these defined terms to better clarify what is meant by "ducts in *conditioned space*" and what components are included in the "total duct leakage test"**
- **Clarify what must be tested during the total duct leakage test (i.e., ALWAYS the return 'ductwork' which now clearly includes sheetrocked plenums, but sometimes air-handler can be excluded if lower allowance is met)**
- **Reduce the use of the phrase "rough-in" and "post-construction" since that is not actually the criteria of importance**

Add a test exemption for ductless systems, including ducted systems with less than 10 ft of ductwork, when in *conditioned space* Provide a greater duct leakage allowance where a greater amount of return ductwork (ducted returns) is installed (like ENERGY STAR).

Bibliography: None

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed changes clarify existing provisions and do not increase the stringency of the requirements.