REPl-91-21

**IECC®: R403.5.4 (New), R403.5.4.1 (New)**

**Proponents:**

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**2021 International Energy Conservation Code**

**Add new text as follows:**

~~R403 .5.4 Compact Hot Water Distribution systems /C HWD).~~

~~Where installed, CHWD systems shall comply with the provisions of section R403 .5.4.1.~~

~~R403 .5.4.1 Water Volume in Pipe Method.~~

~~The hot water distribution system shall store not more than 0.5 gallons (1.9 liters) of water in any piping/manifold between the hot water source and any hot water fixture when calculated using approved engineering calculations. These calculations will use the nominal diameter and length of the piping or tubing, and the longest pipe run from water heater, including both horizontal and vertical run of pipe, shall not be more than 20 feet.~~

 **R403.5.4 Water Volume Determination**

The volume shall be the sum of the internal volumes of pipe, fittings, valves, meters and manifolds between the nearest source of heated water and the termination of the fixture supply pipe. “Heated water” may be defined as the domestic water heater, main hot water supply trunk connected to a demand recirculation pump or heat trace mechanism. The volume in the piping shall be determined from Table R403.5.4.1. The volume contained within fixture shutoff valves, within flexible water supply connectors to a fixture fitting and within a fixture fitting shall not be included in the water volume determination. Where heated water is supplied by a recirculating system or heat-traced piping, the volume shall include the portion of the fitting on the branch pipe that supplies water to the fixture.

[**Table**](https://up.codes/viewer/colorado/iecc-2021/chapter/CE_4/ce-commercial-energy-efficiency#table_C404.5.2.1) **R403.5.4.1**

INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

|  |
| --- |
| **OUNCES OF WATER PER FOOT OF TUBE** |
| **Nominal Size (inches)** | **Copper Type M** | **Copper Type L** | **Copper Type K** | **CPVC CTS SDR 11** | **CPVC SCH 40** | **CPVC SCH 80** | **PE-RT SDR 9** | **Composite ASTM F1281** | **PEX CTS SDR 9** |
| 3/8 | 1.06 | 0.97 | 0.84 | N/A | 1.17 | — | 0.64 | 0.63 | 0.64 |
| 1/2 | 1.69 | 1.55 | 1.45 | 1.25 | 1.89 | 1.46 | 1.18 | 1.31 | 1.18 |
| 3/4 | 3.43 | 3.22 | 2.90 | 2.67 | 3.38 | 2.74 | 2.35 | 3.39 | 2.35 |
| 1 | 5.81 | 5.49 | 5.17 | 4.43 | 5.53 | 4.57 | 3.91 | 5.56 | 3.91 |
| 11/4 | 8.70 | 8.36 | 8.09 | 6.61 | 9.66 | 8.24 | 5.81 | 8.49 | 5.81 |
| 11/2 | 12.18 | 11.83 | 11.45 | 9.22 | 13.20 | 11.38 | 8.09 | 13.88 | 8.09 |
| 2 | 21.08 | 20.58 | 20.04 | 15.79 | 21.88 | 19.11 | 13.86 | 21.48 | 13.86 |

For SI: 1 foot = 304.8 mm, 1 inch = 25.4 mm, 1 liquid ounce = 0.030 L, 1 oz/ft2= 305.15 g/m2.

N/A = Not Available.

**Reason Statement:**

***This new section uses the same Water Volume Determination that already exists in the IECC Commercial Code in section C404.5.2.1. This update has been provided to most easily align residential and commercial hot water service volume calculations in piping.*** *Language needs to be introduced into the prescriptive portion of the code's Systems section to be referenced in new R408 Additional Efficiency Package Options (REPI-142-21).*

Inefficient hot water distribution systems have been recognized as a problem for many years as they result in energy and water waste, and result in long hot water delay times that are the cause of a significant number of complaints by new home buyers. Recirculation systems are a solution to two of the three problems (water and wait time), but the thermal energy impact of different recirculation system options has already been addressed in section **R403.5.1.1 Circulation system.1**

In all non-recirculation distribution options, water heater energy consumption and hot water waste are correlated. A decrease in water heater energy consumption follows a reduction in wasted water; therefore, improving insulation and reducing the piping length and/or pipe diameter have equal benefits for energy and water waste. In recirculation systems, water heater energy consumption and wasted

hot water are independent, and often have an inverse effect (when recirculation is not demand based).2 This distribution system problem exists for a variety of factors including:

* An outdated pipe sizing methodology in the plumbing code that results in oversized hot water distribution systems since the assumed fixture flow rates are much higher than current requirements.
* Municipalities with design recommendations that force plumbers and designers to assume low supply water pressure , resulting in larger distribution piping, which waste more water and energy.
* Increasing efforts to conserve water has resulted in the realization of water savings due to improvements in showerhead and lavatory maximum flow rates; however, reduced flow rates often result in increased wait times if the hot water distribution system is not designed to accommodate lower flows.
* Increasing popularity of gas instantaneous water heaters, which offer improved operating efficiency, but can result in increased water waste when starting from a "cold start up" situation.
* Inefficient plumbing installations that are not focused on minimizing pipe length or pipe diameters.

The IECC has already addressed pipe insulation and Circulation systems in the 2021 IECC Residential provisions.

*Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility*

Farhad Farahmand, TRC Companies Yanda Zhang, ZYD Energy

2*Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation

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*Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility* Farhad Farahmand, TRC Companie ;Yanda Zhang, ZYD Energy

*Evaluating Domestic Hot Water Distribution System Options With Validated Analysis Models* E. Weitzel and M. Hoeschele Alliance for Residential Building Innovation

California Energy Codes & Standards Case Report for *Compact Hot Water Distribution ;* Measure Number: 2019-RES-DHW1 -F, Residential Plumbing

Home Innovation Research Labs Annual Builder Practices Survey, 2021

Department of Energy Zero Energy Ready Home National Program Requirements (Rev. 07) [footnote 15] Efficient hot water distribution system - USBGC LEED BD+C: Homes v4 - LEED v4

Residential Hot Water Distribution Systems: Roundtable Session; JD Lutz, Lawrence Berkely National Laboratory; G Klein, California Energy Commission; D Springer, Davis Energy Group; BO Howard, Building Environmental Science & Technology

**Cost Impact:**

The code change proposal will neither increase nor decrease the cost of construction.

Incremental first costs to builders, designers, and plumbers are design based and each builder will need to determine potential cost impacts based on existing designs and measures in use. Depending on current practices and paths taken for IECC compliance this measure may result in small incremental cost increases or decreases. These potential cost differences relative to standard practices are likely to be:

Reduced cost of PEX or copper tubing due to less material installed. Reduced cost to pipe insulation due to smaller plumbing layout.

Reduced or neutral cost in labor hours for plumber.

Increased water heating venting costs, if a gas water heater or electric heat pump water heater is centrally located.

Increased venting labor costs, if a gas water heater or electric heat pump water heater is located is centrally located and not on a garage wall.

This measure should not have maintenance costs associated with it compared to standard practices. REPl-91-21