REPl-142-21

**IECC®: 408.2.6 (N1108.2.6) (New), 403.5.4 (N1103.5.4) (New), 403.5.4.1 (N1103.5.4.1) (New)**

**Proponents:**

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**2021 International Energy Conservation Code**

**Add new text as follows:**

~~408.2.6 (N1108.2.6) Improved Domestic Hot Water Distribution.~~

~~The hot water distribution system shall meet Section R403 .5.4 and shall be paired with a drain water heat~~ *~~recover~~* ~~system per Section R403 .5.3. The storage limit specified by R403 .5.4 shall be measured from the water heating source to the fixture itself. In addition, no more than 0.6 gallons (2.3 liters) of water shall be collected from the hot water fixture before hot water is delivered. The~~

~~fixture with the greatest stored volume between the fixture and the hot water source (or recirculation loop) will need to be tested. To field verify that the system meets the 0.6 gallon (2.3 liter) limit, verifiers shall first initiate operation of on-demand recirculation systems, if present, and let such systems run for at least 40 seconds. In accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07). Next, a bucket or flow measuring bag (pre-marked for 0.6 gallons) shall be placed under the hot water fixture. The hot water shall be turned on completely and a digital temperature sensor used to record the initial temperature of the water flow. Once the water reaches the pre-marked line at 0.6 gallons (approximately 24 seconds for a lavatory faucet), the water shall be turned off and the ending temperature of the water flow (not the collection bucket) shall be recorded. The temperature of the water flow must increase by not less than 10 °F (5.6QC).~~

* + 1. ~~(N1103.5.4) Compact Hot Water Distribution systems (CHWD).~~

~~Where installed, CHWD systems shall comply with the provisions of section R403.5 .4.1.~~

* + - 1. ~~(N1103 .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 (6.1ml.~~

**408.2.6 (N1108.2.6) Compact Hot Water Distribution**

For Compact Hot Water Distribution system credit, the volume shall store not more than 16 ounces of water ~~in~~ between the nearest source of heated water and the termination of the fixture supply pipe ~~the piping between the hot water source and any hot water fixture~~ when calculated using section R403.5.4 ~~and R403.5.4.1~~.

To field or plan review verify that the system meets the prescribed limit, one of the following must be done:

1. At plan review
   1. Referencing ounces of water per foot of tube on plans as per Table R403.5.4.1
2. At rough in (plumbing)
   1. Referencing ounces of water per foot of tube installed as per Table R403.5.4.1
3. At final inspection
   1. In accordance with Department of Energy's Zero Energy Ready Home National Specification (Rev. 07 or higher) footnote on Hot water delivery systems.

**Reason Statement:**

**This section is being re-submitted to better align with credit provided for compact hot water distribution outlined in section R405.4 and Table R405.4.2(1), building component “service water heating,” utilizing HWDS or the factor for the compactness of the hot water distribution system.** 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.

*1Residential Compact Domestic Hot Water Distribution Design: Balancing Energy Savings, Water Savings, and Architectural Flexibility*

Farhad Farahmand, TRC Companies and 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

**Savings:**

The following savings have been calculated for compact domestic hot water distribution only, as Drain Water Heat Recovery has already been included in the 2021 IECC. The California Energy Codes & Standards Case Report for *Compact Hot Water Distribution.*

Measure Number: 2019-RES-DHW1-F, Residential Plumbing 3 performed savings analysis using 16 California climate zones. This analysis focused on Therm and Water Savings as it's estimated that over 75% of Residential New Construction Water Heaters installed are gas tankless systems. Nationally, ~68% of Residential New Construction Domestic Hot Water systems are gas fueled, according to

the *Home Innovation Research Lab 's Annual Builder Practices Survey, 20214.* California's climate zones correlate approximately to IECC Climate Zones 2, 3b, 3c, 4c, 5b, and 6. Savings estimated should be conservative for climate zones 4c and higher as ground

temperatures and therefore incoming water temperatures in California homes may be 1 to 3°F higher than in these cooler climates.

**Energy Savings Compact Hot Water Distribution Design:** lnclimate zones 3b and lower, first year weighted average residential energy savings (translated from Therms/yr to Mmbtu/yr) are estimated to be per Single Family Home: Climate Zone Savings in Therms Savings in Mmbtu2 are estimated to be per Single Family Home:

|  |  |  |
| --- | --- | --- |
| Climate Zone | Savings in Therms | Savings in Mmbtu |
| 2 and 3b | 4.48 | 0.448 |
| 3c and higher | 5.57 | 0.557 |

These estimates come from assumption of a 2,430 sq ft home with 3.5 bedrooms.

3California Energy Codes & Standards Case Report for *Compact Hot Water Distribution;* Measure Number: 2019-RES-DHW1-F, Residential Plumbing

4Home Innovation Research Labs Annual Builder Practices Survey, 2021

**Water Savings**

Estimated impacts on water use are presented in the table below. Water use savings estimates are challenging given that hot water usage behaviors among individuals and households are highly variable and can depend strongly on the demographics of the household (Parker, D.; Fairey, P.; and Lutz, J.; 2015). In addition, the proposed compliance option approach ensures that compliant hot water distribution systems will be smaller than a conventional non-compact system but cannot precisely specify the design and configuration and hence the impacts on water waste. To provide a best approximation of water savings impacts, the Statewide CASE Team relied on detailed distribution simulation study completed under the U.S. Department of Energy's Building America program (Weitzel, E.; Hoeschele, M. 2014). In these estimates, it was assumed that all water savings occur indoors.

**Impacts on Water Use Table**

|  |  |
| --- | --- |
|  | **On-Site Indoor Water Savings (gal/yr)** |
| Per Dwelling Unit Impacts (single family) | 962 |
| Per Dwelling Unit Impacts (multifamily) | 321 |

**Drain Water Heat Recovery Savings:**

Using the most conservative Department of Energy savings estimates of 800kWh per year, with an U.S. Energy Information Agency hybrid electricity rate for the nation of 13.5 cents per kWh show an annual savings estimate for electric water heating at: $108/yr

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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
        + Code Changes and Implications of Residential Low-Flow Hot Water Fixtures – CEC-500-2021-043. Gary Klein, Jim Lutz, Yanda Zhang, John Koeller.
        + Time-to-Tap and Volume-until-Hot – Water, Energy, and Time Efficient Hot Water Systems. 2020 Educational Institute, March 2020, Gary Klein presentation.

**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.

**Energy Savings and Cost Impact for Drain Water Heat Recovery:** Using the most conservative Department of Energy savings estimates of 800kWh per year savings, with an U.S. Energy Information Agency hybrid electricity rate for the nation of 13.5 cents per kWh, and an increased cost of $1,000 per unit due to increase copper prices; these systems provide an 11 year simple payback.

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