I wanted to thank everyone for the spirited discussion last week. And special thanks to Duane, Jason, Greg, Jonathan, and Kevin for engaging in follow up discussions. I wanted to provide some additional information and an amended version of the 047 proposal to address some of the comments brought up. Kjell and Krista, please accept the attached Code Change Form as a friendly amendment based on the comments below and the general discussion during the previous TAG meeting.

Comment #1 – The code as written would violate IPC or UPCs. In particular, this was brought up in regards to 046 as new code language, to be referenced by Table R406.3 or any performance approach to codes, in order to ensure that measuring volume of water in the plumbing supply system will hold no more than a pint of water from the source of heat*

This is the table in proposal 046 (and is already in the WSEC-C):

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
1 1/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
1 1/2	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/ft^2= 305.15 g/m^2.

N/A = Not Available.

This is what is in the 2018 UPC and IPCs:

2018 UPC

TABLE L 502.7
WATER VOLUME FOR DISTRIBUTION PIPING MATERIALS*

OUNCES OF WATER PER FOOT LENGTH OF PIPING													
NOMINAL SIZE (inch)	COPPER M	COPPER L	COPPER K	CPVC CTS SDR 11	CPVC SCH 40	PEX-AL- PEX	PE-AL- PE	CPVC SCH 80	PEX CTS SDR 9	PE-RT SDR 9	PP SDR 6	PP SDR 7.3	PP SDR 11
⅜	1.06	0.97	0.84	NA	1.17	0.63	0.63	NA	0.64	0.64	0.91	1.09	1.24
½	1.69	1.55	1.45	1.25	1.89	1.31	1.31	1.46	1.18	1.18	1.41	1.68	2.12
¾	3.43	3.22	2.90	2.67	3.38	3.39	3.39	2.74	2.35	2.35	2.23	2.62	3.37
1	5.81	5.49	5.17	4.43	5.53	5.56	5.56	4.57	3.91	3.91	3.64	4.36	5.56
1¼	8.70	8.36	8.09	6.61	9.66	8.49	8.49	8.24	5.81	5.81	5.73	6.81	8.60
1½	12.18	11.83	11.45	9.22	13.20	13.88	13.88	11.38	8.09	8.09	9.03	10.61	13.47
2	21.08	20.58	20.04	15.79	21.88	21.48	21.48	19.11	13.86	13.86	14.28	16.98	21.39

For SI units: 1 ounce = 29.573 mL
* NA: Not Applicable

2018 IPC

TABLE E202.1
INTERNAL VOLUME OF VARIOUS WATER DISTRIBUTION TUBING

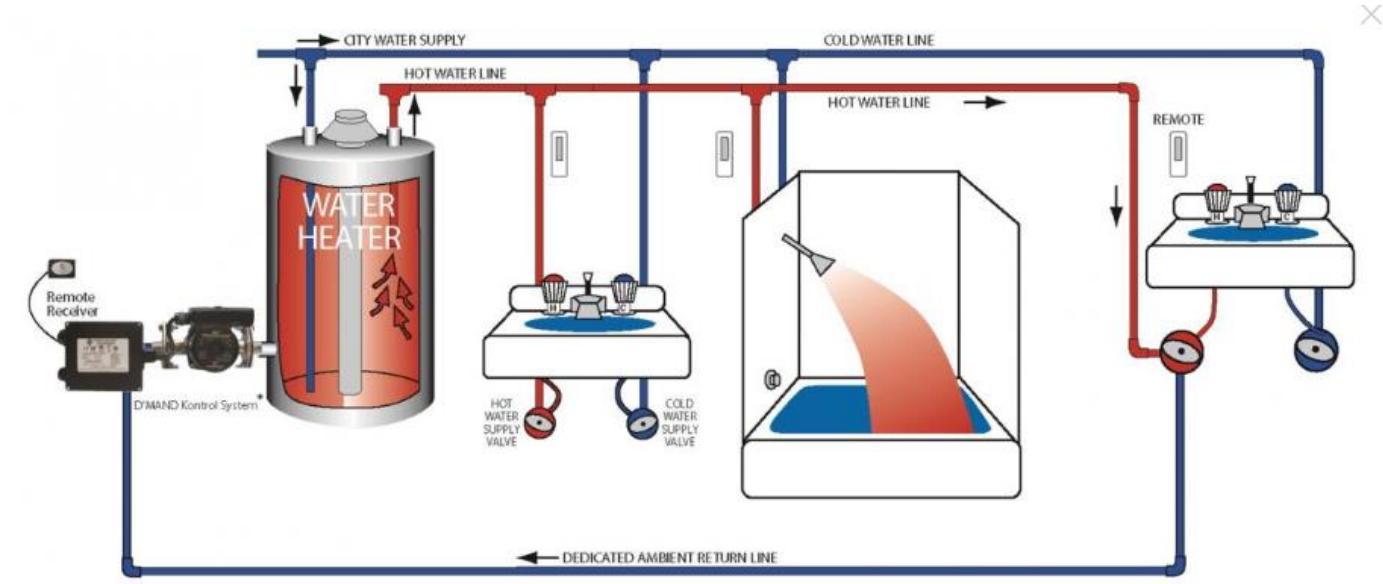
OUNCES OF WATER PER FOOT OF TUBE									
Size Nominal, Inch	Copper Type M	Copper Type L	Copper Type K	CPVC CTS SDR 11	CPVC SCH 40	CPVC SCH 80	PE-RT SDR 9	Composite ASTM F 1281	PEX CTS SDR 9
3/8	1.06	0.97	0.84	N/A	1.17	—	0.64	0.63	0.64
1/2	1.69	1.55	1.45	1.25	1.89	1.46	1.18	1.31	1.18
3/4	3.43	3.22	2.90	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
1 1/4	8.70	8.36	8.09	6.61	9.66	8.24	5.81	8.49	5.81
1 1/2	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 ounce = 0.030 liter.

*Source of heat is either a water heater or the nearest portion of the plumbing distribution system as primed by a demand recirculation pump in the amended proposal.

Comment #2: On Demand recirculation systems typically use the cold-water line for the house and that's not a good design for a number of reasons.

This is true in existing homes, where re-designing the plumbing layout is not practical. In the Residential New Construction, this is the recommended design (which will now be referenced in the amended 047 proposal):



A demand plumbing layout uses a recirculation pump to speed delivery of hot water to plumbing fixtures.

Comment #3: We should put a floor or size limit of home that this could apply to (meaning not to be given credit in small homes as it's easier to do).

While this is easier in smaller homes, it is certainly not done regularly outside of Habitat for Humanity homes, and then, only in a few affiliated neighborhoods. It is our contention that there should NOT be a limitation on home size for this proposal as it is more common that smaller homes are also in the affordable housing sector and these homes should be given every opportunity meet the necessary credits.

Comment #4: There's not enough evidence that this can work in ranch homes or in general that this can be done regularly and well.

Attached is an ACEEE white paper and structured plumbing presentation, both shared with me by Gary Klein, who has studied this work for decades and has seen this done both in design and in the field, in residential new construction and in retrofits.

The supplemental information I included to both lab testing and real-world tests in California that show On Demand recirculation when combined with compact hot water distribution does save energy when compared to waiting for water to become "usefully hot" or 105°F. Essentially, waiting for water to get hot wastes both regular water as well as hot water as it takes time and energy to get the water in the pipes to a hot level.

Comment #5: Are there any other codes that have already adopted or approved this?

Yes, California's Title 24 has this in the code, but with a 26-ounce limit (.2 gallons), but is looking to drop this to 16 ounces in the next cycle. In the IECC-R, both the prescriptive code language and the additional credit have been passed through the HVAC subcommittee, currently being reviewed for minor language recommendations from the SEHPCAC group. Once finalized, this will be voted on by the full IECC-R consensus committee for inclusion in the 2014 IECC. PNNL is currently doing modeling to determine the amount of points relative to other "Additional Energy" credits being proposed. Note, the WSEC-R will now specify in the amended language that any recirculation system in new construction must contain a dedicated ambient return line and all recirculation systems must be demand controlled (push button or motion sensor), not run continuously or on a timer. Effectively, the WSEC-R will be more restrictive.

Comment #6: 6 feet of plumbing from any hot water source is unrealistic!

As per the charts below that make up Proposal 046 – Hot Water Volume Determination, and with this table to simplify, for 16 oz's of water in a pipe, we are talking about 16 feet of 3/8" copper [L type] (from the heated loop) or 24 feet of 3/8" PEX. If/when IAPMO and others allow ¼" piping to final fixtures, this will be even easier, but that's an issue for another day.

LENGTH OF PIPE THAT HOLDS 8 oz OF WATER

	3/8" CTS	1/2" CTS	3/4" CTS	1" CTS
	ft/cup	ft/cup	ft/cup	ft/cup
"K" copper	9.48	5.52	2.76	1.55
"L" copper	7.92	5.16	2.49	1.46
"M" copper	7.57	4.73	2.33	1.38
CPVC	N/A	6.41	3.00	1.81
PEX	12.09	6.62	3.34	2.02
Ave	**8 feet**	**5 feet**	**2.5 feet**	**1.5 feet**

So, the savings come from either a combination of demand controlled recirculation + ~16 feet of branch/twig piping to the furthest fixture (the most likely scenario by far as we both agree) OR ~16 feet of copper or 24 feet of PEX from a warmed manifold or local water heater (likely only to be found in small Habitat for Humanity type homes or ultra-green homes that invest in stacked or core plumbing layout designs).

Finally, yes, there is an associated cost for redesign of these plumbing layouts and a cost for the demand recirculation pump. I have not updated the costs on my analysis, but one could say that the plumbing design could result in reduced cost due to less plumbing lines, combined with the increase in cost of a demand recirculation pump. Combining those two together, could be a net increased cost that is near the $300 that I assumed in initial analysis.

Comment #7: So builders will have to install an On Demand recirculation pump?

Not necessarily, houses that have a compact hot water design (typically core plumbing layouts, stacked plumbing designs, central water heaters with short home run distribution boxes, or homes with point source water heating) could so get the credit. The updated credit proposal states that IF a home is utilizing a recirculation system, it must be on demand and have a dedicated ambient return line.

My question to you the TAG, if we assume that the savings Gary (and other researchers) have found to be real with demand recirculation and short plumbing lines to the furthest fixture, is whether the amended proposal covers the bases and ensures that IF this credit is selected, we have the necessary guidance in place to ensure the savings are realized.

For Compact Hot Water Distribution system credit, the volume shall store not more than 16 ounces of water between the nearest source of heated water and the termination of the fixture supply pipe where calculated using section R403.5.4 *Construction documents* shall indicate the ounces of water in piping between the hot water source and the termination of the fixture supply. When the hot water source is the nearest primed plumbing loop or trunk, this must be primed with an On Demand recirculation pump and must run a dedicated ambient return line from the furthest fixture or end of loop to the water heater.

Thank you again for all of the feedback and considerations put into this and for committing to ensure that this proposal makes sense and for spending the time to talk this through with me.