Alternative Methodology for Sizing Water Pipes

California Plumbing Code July 1, 2024

Complete Report

This report analyzes the benefits of using the Uniform Plumbing Code (UPC) Appendix M Water Demand Calculator (WDC) method to right-size the supply piping for current plumbing of fixtures and appliances. Engineering rules for sizing water supply piping were published in the early 1940s and incorporated into the model plumbing codes shortly thereafter. California Plumbing Code (CPC) Appendix A is based on the UPC Appendix A model code, which is, in turn, based on these engineering rules. UPC Appendix M Peak Water Demand Calculator offers an alternative methodology for sizing water pipes in new single family and multifamily buildings.

The Statewide Utility Codes and Standards Team submitted a Title 24 Petition to adopt UPC Appendix M into the CPC during the 2022 Intervening Code Adoption Cycle. If adopted, UPC Appendix M would serve as an alternative methodology to UPC/CPC Appendix A for sizing water pipes in new single family and multifamily buildings. The petition was submitted to California Buildings Standards Commission, the California Department of Housing and Community Development, and the California General Services Administration Division of the State Architect staff members in November of 2021. Statewide adoption of UPC Appendix M into the CPC would enable the voluntary use of Appendix M for all residential occupancies that fall within the jurisdictions of adopting state agencies. Statewide adoption would make it equally convenient to use Appendix A or Appendix M.

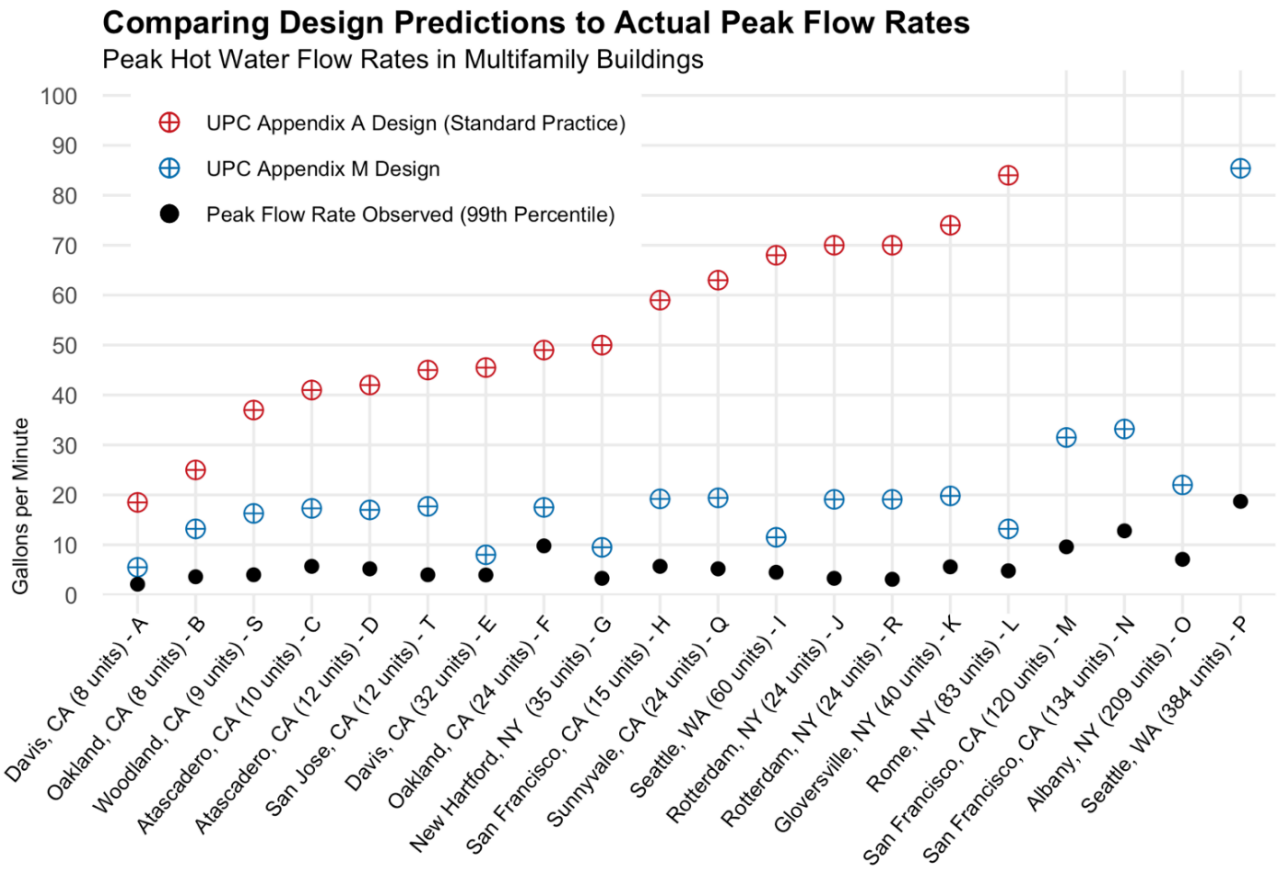
The analysis compared UPC Appendix A and M design predictions to actual data for hot water flow rates in 20 multifamily buildings, which range in size from 8 to 384 apartments. The monitoring period ranged from 9 days to over 2 years, and logging interval ranged from 1 to 60 seconds depending on the building. The team primarily analyzed actual data for hot water flow rates because hot water data was readily available from data collection efforts serving energy efficiency projects not related to water pipe sizing.

If UPC Appendix M is adopted by California state agencies during the 2022 Intervening Code Cycle, statewide adoption will be effective July 1, 2024. In the meantime, there is an opportunity for early adoption of UPC Appendix M by local jurisdictions to facilitate the use of the alternative pipe sizing methodology on construction projects.

Figure 1 compares the monitoring data from these studied multifamily buildings to the peak hot water flow rate estimates based on UPC Appendix A (red crosshairs) and UPC Appendix M (blue crosshairs). This

comparison shows that UPC Appendix M is a more accurate, but still conservative, approach to estimating peak water flow rates.

Figure 1. Comparison of Design Predictions to Actual Peak Flow Rates



Many thanks to the Association for Energy Affordability, Ecotope, Frontier Energy, Peter Skinner, and the UC Davis Western Cooling Efficiency Center for providing data.

The report identifies two types of savings outlined below.

- Construction cost savings result from:
  - Smaller diameter pipes and fittings, valves, pumps, and other equipment,
  - Smaller inside diameter pipe insulation, and
  - Smaller water service entrance size, which allows smaller water meter size with lower connection fees.
- Operational cost savings, which will continue for the life of the building, result from:
  - Water savings from faster hot water delivery, producing smaller monthly water service charges and lower associated volumetric sewer charges,

- Energy savings due to decreased heat loss in the hot water distribution system, particularly in multifamily buildings with a recirculation system, and
- Embedded energy savings for the water and wastewater utilities due to customer indoor water savings.

The reduction in construction costs from right-sizing the supply piping is on the order of $600-$1,200 per apartment for multifamily buildings.

Table 1 offers preliminary conservative estimates for annual water and energy savings per dwelling unit.

Table 1. Estimated Annual Water and Energy Savings Per Dwelling Unit

Building Type	Water Savings (gal/Dwelling Unit per Year)	Embedded Electricity Savings (kWh/Dwelling Unit per Year)	Natural Gas Savings (therms/Dwelling Unit per Year)
Low-Rise Loaded Corridor, 3-story, 24-unit building in Sunnyvale, CA	404	2.0	7.1
Prototype Low-Rise Garden Style, two-story, eight-unit building	257	1.2	2.8 - 3.0
Prototype Mid-Rise Loaded Corridor, three-story, 36-unit building	320	1.6	3.7 - 4.0
Prototype Mid-Rise Mixed-Use, five-story, 96-unit building	234	1.1	4.0 - 4.5
Prototype High-Rise Mixed-Use, 10-story, 108-unit building	248	1.2	4.4 - 4.9
Single Family Dwelling	1,096	5.3	7.7

The estimates of natural gas savings assume water heating using natural gas. For dwellings on a heat pump water heater instead of natural gas water heater, the estimated natural gas savings would need to be converted into electricity savings, accounting for a different water heater efficiency factor.

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