



Trends in Shower Design and Their Effect on Energy and Water Use

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Current U.S. Regulations



- **EPA Act 1992–Federal Energy Policy Act of 1992**
 - **ANSI / ASME A112.18.1M-1996 test procedure**
- **No more than 2.5 gpm at 80 psig (9.5 L/min)**
- **Harmonized voluntary standard:**
 - **ASME A112.18.1-2005/ CSA B125.1-05**
 - **Not referenced by Federal regulation**
 - **No big changes to showerhead part**
 - **Definition of body spray added (same 2.5 gpm)**

Enforcement



- **California Energy Commission directory of self reported values**
- **CEC tested in 1980s**
- **Little or no enforcement**
- **Past testing showed many violations**
- **Most recent testing of 7 showerheads showed major violations**

Examples



- **Internet advertisement**
 - **10 gallons per minute (gpm) showerhead**
- **Incorrect label**
 - **Showerhead labeled 2.0 gpm - but flow rate testing showed 13 gpm**
- **Multi-head shower system advertisement:**
 - **“up to 21 gallons per minute”**

Motivations



- **Consumers not satisfied with current single head showerheads flow, coverage or other attributes**
- **Desire to use shower for an experience similar to a whirlpool tub or spa**

- **Moen (manufacturer): 66% wanted more force**
- **Westin: 66% wanted more water flow, 60% wanted more force**
 - **Tested 150 showerheads, installed custom-designed showers having two heads**
- **Holiday Inn Express: chose a single headed showerhead**
 - **tested showerheads with 7,000 guests**

Types of Showerheads and Shower Systems



- **Single-head**
- **Multiple-head**
- **Cascading**
 - **Rain shower, downpour**
- **Shower panel / shower tower**
- **Body spas**
 - **Non-recirculating**
 - **Recirculating**
- **Rain systems**
- **Water tiles**

Single Head



Multiple head



Cascade / Downpour



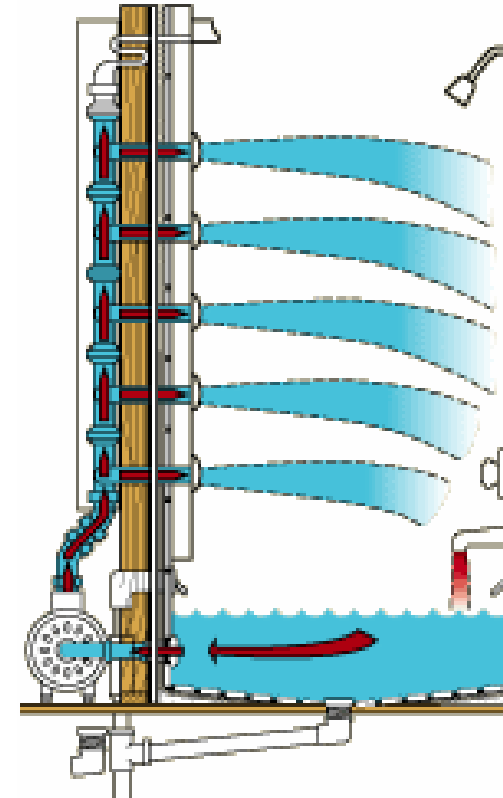
Shower panel or shower tower



Body Spa



Body Spa with recirculation



Rain System



Water Tile



Is trend big enough to worry about?



- Multiple showerhead systems becoming more popular ~ 4% of new houses
- Let's estimate potential increase in water and energy use

- **Collect best data available**
- **Estimate *most likely value* and *maximum* and *minimum* values**
 - Range of input parameter depicts uncertainty of *average values* NOT *variability* of parameters
- **Use Monte Carlo software to generate a distribution and average value**
 - Select a uniform or triangular distribution
- **For some parameters single value inputs are used**
 - Fuel price, fuel used by water heater

Data & Assumptions



Parameter	Value				
	Mean	Most likely	Min.	Max.	Type of Distribution
General Inputs					
U.S. population (million)	290	n/a	n/a	n/a	n/a
Persons per household	2.59	n/a	n/a	n/a	n/a
Showers per day	0.7	0.7	0.65	0.75	Uniform
Average shower duration (minutes)	8.2	8.2	8	8.4	Triangular
Flow Rates of Showerheads (gpm)					
Flow of average showerhead (1999 baseline)	2.2 gpm	2.2	2.0	2.4	Triangular
Flow of multiple-head showerheads	5.5	4	2.5	10	Triangular
Percentages of Different Showerheads					
Percent multiple-head showerheads	4.3%	4%	3%	6%	Triangular
% of time multiple-head SH is used	75%	75%	50%	100%	Uniform

Data & Assumptions –single value



Electricity Rate (per kWh)	\$.0906
Natural Gas Rate (per Therm)	\$ 1.092
Water & Wastewater Rate (per 1000 gallons)	\$3.19
Cold water inlet temperature	60°F
Shower temperature	105°F
Electric water heater recovery efficiency	98%
Gas water heater recovery efficiency	75%
Percent of water heaters using electricity	42%
Percent of water heaters using gas	58%

Water Savings Uncertainty Distribution (as a percent of baseline shower water use)

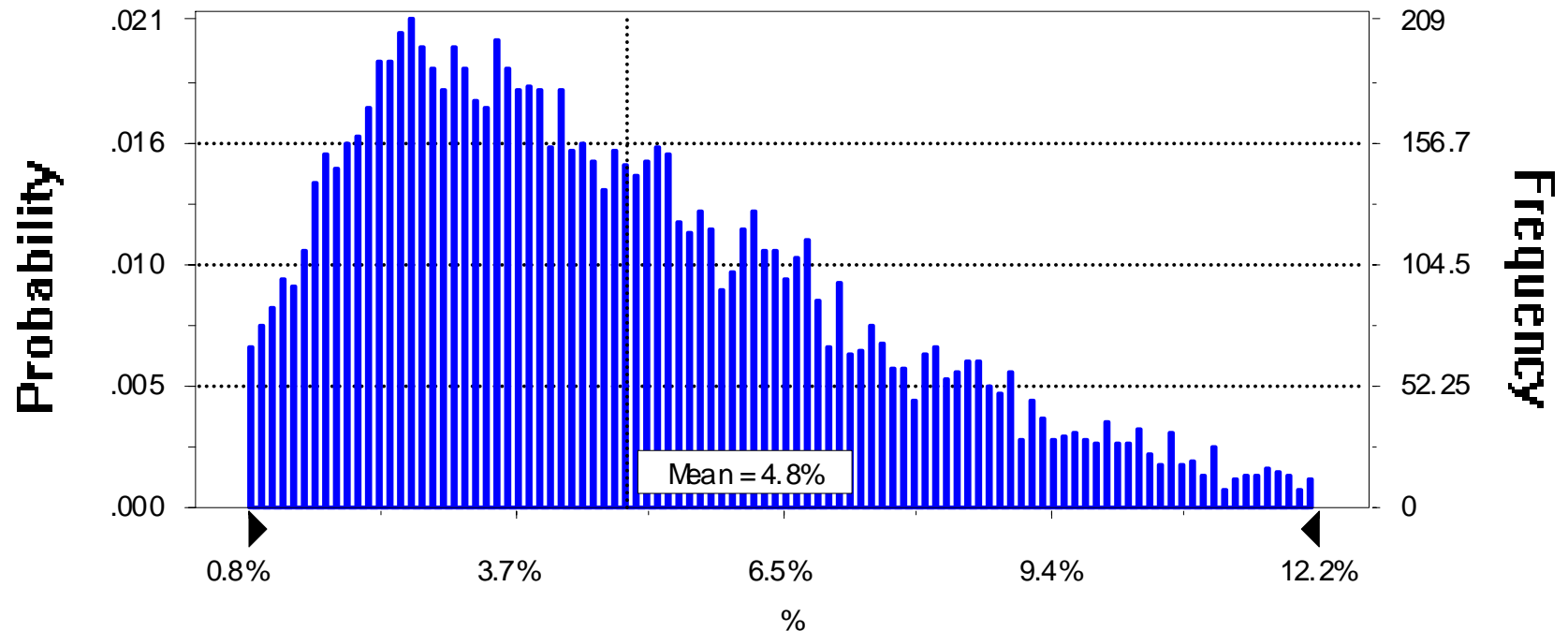


Forecast: %Water Saved 4

10,000 Trials

Frequency Chart

295 Outliers



Increase in baseline shower water consumption due to trends in showerheads – all else remaining unchanged

Summary of Water & Energy Use Increase



- **Potential increase of:**
 - 177 million gallons of water per day (670 L)
 - 8.4 gigawatt hours per day electric water heating
 - 516 kilo-therms per day of gas water heating (15.1 GWh)
- **Baseline water use**
 - 3.7 billion gallons per day (3,662 acre feet)
 - 16.8% of residential indoor water use

What data & research is needed?



- **Data & research is needed to better estimate future water and energy consumption and to develop strategies to reduce consumption**
- **Two types of information**
 - **Behavioral Information**
 - **Product Information**

Behavioral Information



- **How often are high-water-using showers used?**
- **Duration of high-water-using showers?**
- **Are showers with multiple showerheads with separate control valves used simultaneously?**
- **On body spas - are re-circulated systems used in that mode?**
- **Are body spas replacing whirlpool spas or will they be used in addition to tubs?**
- **Does flow rate of shower effect the water temperature used?**

Product Information



- **Flow rate of multiple showerheads on the market**
- **Sales distribution of high flow showerheads**
- **Future trends – a passing fad or here to stay?**
- **How many showerheads are not in compliance?**

Effect on Water Heater Size and Plumbing



- **How do you keep from running out of hot water at higher shower flow rates?**
- **Will the size of water heaters become larger?**
- **Will larger water distribution piping become standard to accommodate higher flows?**
- **Will installation of high flow shower systems drive the conversion to demand (tankless) type water heaters?**
- **What are the effects of the above on water and energy usage?**

What have others done regarding this issue?



- **City of Calgary Canada considered limiting the size of shower stall drains**
 - **Didn't move forward on this due to liability and safety issues**
- **Considered limiting showerhead flow to 2.5 gpm per control valve**
 - **Contractors said they would simply add more control valves**
- **City decided it needed more information before pursuing further action**

What should be done to mitigate water and energy use of showers?



- Is independent testing for enforcement needed?
- Do regulations need to be modified to include body spas, or clarify the rules for multiple-head showerheads?
- What are ways to implement decisions?
 - ASME / CSA code
 - Federal Government Regulations
 - State water use regulations
 - Building codes

Clarify Regulations



- **Is it permissible to have multiple showerheads controlled by one shut off valve if the total flow is greater than 2.5 gpm?**
- **Is a body spa a shower?**
 - **If not – should it be regulated**
 - **What if it recirculates, can the showerhead then have a higher flow rate?**

Voluntary Measures



- **Establish a testing program that rates the performance of showerheads in addition to whether or not they meet the maximum flow requirements**
 - **Helps consumers select a showerhead saves water without sacrificing shower experience**
 - **Test for force, coverage, temperature**

Next Steps?



- **Enforcement**
 - **Independent Testing**
 - **Clarify existing regulations**
- **Research**
 - **Field use**
 - **Market trends**
- **New Test Procedures**
 - **For consumer satisfaction**



Thank You!

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Violating the Regulations: Some Test Results



Manufacturer	Model #	Flow rate* (GPM)	Label (GPM)
Watermark	SH-FAL70	7.62	2.0
Watermark	SS-RH080	13.00	2.0
Watermark	SS-RH500	8.19	2.0
Watermark	SS-RH600	9.10	2.0
Nautilus	II	12.70	None

* At 80 psi

Potential Test Procedure



- **Performance Testing**
 - Rate showerheads by objective repeatable testing (coverage, temperature, force, etc?)
 - Allows choice of water saving showerheads without sacrificing shower experience
- **Safety Testing**
 - Low flow showerheads and sudden temperature changes due to change in water pressure
 - Temporary shutoff valves
- **Evaluation of Human Factors Affecting Energy & Water Use**
 - Is it possible to quantify parameters of shower experience
 - Relationship between temperature and water flow

See Proposal for Showerhead Testing and Evaluation for details

Showerhead performance metric



- **Metric can include:**
 - Temperature
 - Pressure
 - Spray pattern
- **Metric should be researched – requires testing**
- **Additional testing for**
 - Flow rate compliance
 - Safety
 - Tub spouts
 - Basic data from field testing
 - Test different types of showerheads

Research?



- **Collect data**
 - Can buy sales data with model numbers (but flow is not included in this data)
 - Can buy showerheads at popular stores and test for flow

Other problems & solutions



- **Water is wasted while waiting for the hot water to arrive at the showerhead**
 - **Use a device that pumps hot water to the site and recirculates cold water back to the water heater**
 - **A device is marketed that shuts off the water as soon as hot water gets to the showerhead – the idea is that while waiting for the shower to get hot, people go do something else; hot water goes down the drain before they get into the shower**
 - **Put water heaters closer to the shower**

Instructions: How to Violate the Regulations



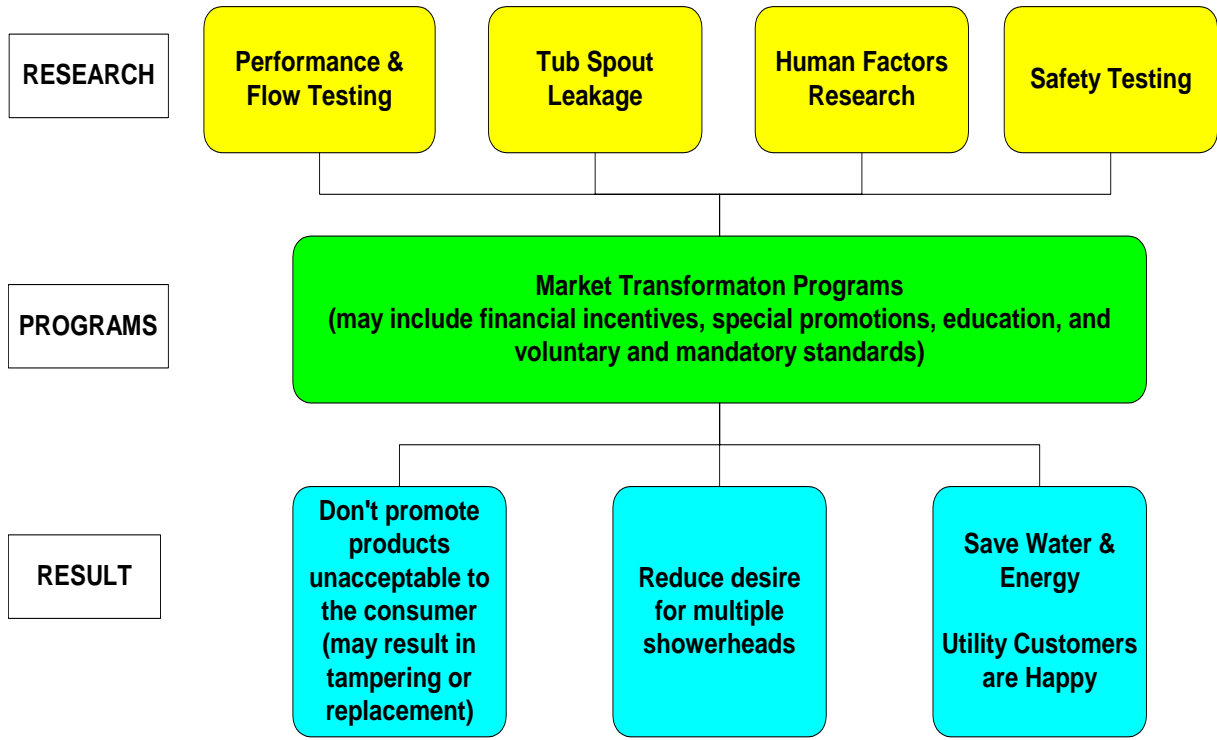
- **Some web sites and product instruction sheets tell you how to remove the flow restrictor to increase the flow**

Live in a low water pressure area or a high-rise building?

Not happy with your current water-saving shower head?

*All our shower heads feature removable flow restrictors
to maximize power and pressure.*

Linkages between Research, Conservation Programs and Results



What is the purpose of this presentation?



- **Create awareness of new trends in shower designs that influence the usage of water and energy**
- **Present terminology of new shower systems**
- **Present background information on regulations**
- **Estimate the magnitude of potential increase in energy and water use**
- **Discuss issues and actions to be taken**

Report ranking potential savings



Rank	Scenario	Percent Water Savings
1	Counteract trend toward multiple showerheads, etc.	25%
2	Reduce average showering time by 1 minute	17%
3	Change all the showerheads that meet code to below code	15%
4	Change all showerheads that exceed code to meet code	7%
5	Reduce number of showerheads tampered with	1%
6	Reduce tub spout leakage	<1%

Details in report: Potential Water and Energy Savings from Showerheads, Peter Biermayer

Overview



- **Some new shower systems and showerheads use more water than allowed by U.S. DOE regulations**
- **Multiple showerhead systems becoming more popular ~ 4% of new houses**
- **Greater water use also means more energy to heat the water**
- **Are potential increases in water and energy use large enough to worry about?**