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SERVICE & DOMESTIC HOT WATER

LAMINAR FLOW RESTRICTOR

SWWH004-02

CONTENTS

MEASURE NAME

Laminar Flow Restrictor

STATEWIDE MEASURE ID

SWWH004-02

TECHNOLOGY SUMMARY

A laminar flow restrictor (LFR), also known as a laminar flow device, is a faucet "add-on" for hospitals and healthcare facilities, including clinics and nursing homes. Due to regulations, hospitals are prevented from using faucet aerators. Basic aerators reduce faucet water flow by adding air, thus saving water and energy. However, traditional aerators introduce air and turbulence to the water stream, which allows bacteria and biofilm to develop: this feature prevents them from being deployed in health care environments with sensitive populations present. Installing a LFR will change water flow patterns to produce laminar flow that does not entrain air and will result in a reduced flow rate that saves energy and water.

The Office of Statewide Health Planning and Development (OSHPD) bans the use of aerators in the health care industry due to aerator flow control methods and components.[1] The mixing of air and water within the aerator allows airborne bacteria to become waterborne and, in warm stagnant conditions, promote bacterial growth. The increased surface area of aerator components (e.g. screens) allows hard water deposits and biofilm to accumulate within the device which may further harbor increased bacterial growth.

The LFR device is installed at the outlet of the faucet spout to reduce water consumption. In practice, the LFR differs from an aerator because it produces a transparent stream of water without introducing air into the flow. The table and figure below summarize the differences between LFRs and aerators.[2]

Key features of the LFR are straightening vanes and the prevention of bacteria development: [3]

Straightening Vanes. Straightening vanes are used in the LFRs in lieu of the metal wire mesh in traditional aerators. They are introduced in the flow path to keep the water flow laminar. Inlet-ends of the vanes are configured to minimize shear stress. The reduction in shear stress at the inlet of the LFR prevents the development of air bubble entrainment in the exiting water stream.

Prevention of Bacteria Development. Turbulence in the outlet of an aerator allows airborne bacteria to entrain itself to the water flow. The water exiting the LFR sustains a laminar profile, which significantly

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[1] Office of Statewide Health Planning and Development (OSHPD). 2017. *Health Facility Checklist Section 1226 [OSHPD 3] Clinics. 1226.6 Primary Care Clinics*. Updated April 4. Page 5 Section 1226.6.3.1; Page 6 Section 1226.6.6.1.

[2] NEOPERL, Inc. 2015. *NEOPERL Products, No.6*.

[3] NEOPERL, Inc. http://www.neoperl.com.

mitigates air bubble development within the LFR and drastically reduces the opportunity for bacteria growth within the restrictor.[4]

Comparison of Laminar Flow Restrictor and Faucet Aerator

In addition to preventing air entrainment, some LFRs have silver-zeolite incorporated into the plastic resin which strengthens the ability of the restrictor to kill harmful bacteria on contact. Bacteria that could otherwise develop between uses is killed by releasing a silver ion onto the moisture film.[5] This silver zeolite coating is an additional benefit to the environment of health care professionals within hospitals, medical offices, nursing homes, and other health care facilities.

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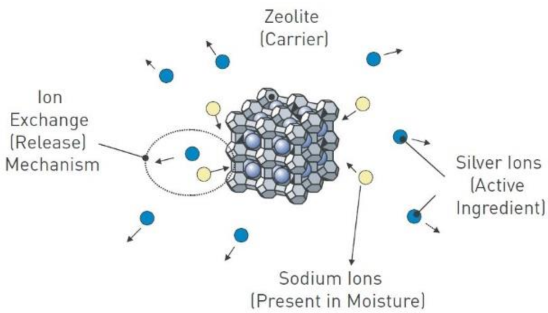
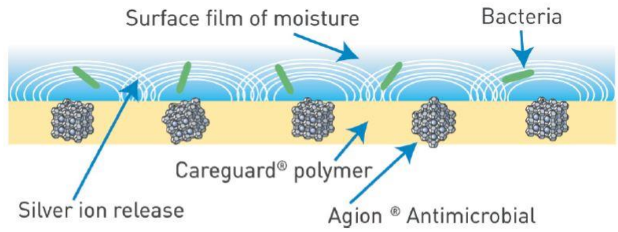
[4] Tamanai-Shacoori, Z., Chandad, F., Rébillard, A., Cillard, J., & Bonnaure-Mallet, M. 2014. "Silver-Zeolite Combined to Polyphenol-Rich Extracts of Ascophyllum nodosum: Potential Active Role in Prevention of Periodontal Diseases." PLoS ONE 9(10): e105475.

[5] Tamanai-Shacoori, Z., Chandad, F., Rébillard, A., Cillard, J., & Bonnaure-Mallet, M. 2014. "Silver-Zeolite Combined to Polyphenol-Rich Extracts of Ascophyllum nodosum: Potential Active Role in Prevention of Periodontal Diseases." PLoS ONE 9(10): e105475.
Saengmee-anupharb, S., T. Srikhirin, B. Thaweboon, S. Thaweboon, T. Amornsakchai, S. Dechkunakorn, and T. Suddhasthira. 2013. "Antimicrobial effects of silver zeolite, silver zirconium phosphate silicate and silver zirconium phosphate against oral microorganisms." Asian Pac J Trop Biomed. 2013 Jan; 3(1): 47–52.

Molecular Behavior of Silver Zeolite Coating





MEASURE CASE DESCRIPTION

The measure case is defined as a laminar flow restrictor that is installed at the outlet of a faucet spout in a health care facility to reduce the flow rate. Unit savings were estimated for each measure offering and in each California climate zone.

Measure Case Specification

Faucet Type	Flow Rate (gpm)
Public or Private Lavatory or Kitchen	0.5
	1.0
	1.2
Kitchen Only	1.5
	1.8

BASE CASE DESCRIPTION

The base case technology for this measure is the existing faucet spout with a flow rate of 2.7 gpm *without* a flow restriction device. This flow rate is derived from data obtained from a hot water fixture flow survey employing data collected by Water Saver Solutions between 2011 and 2014.[6]

The methodology and results of this data collection are summarized below.

Sample. The survey collected data on health care facility locations, faucet counts and types, and the measured flow rates, from 24 hospitals, one medical office building, and one nursing home; all but four of the hospitals are located the Southern California Gas Company (SCG) service territory.

Data Collection Methods. There were three methods used for measuring the existing flow rates: 1) the measuring cup, 2) bag, and 3) digital flow meter. Over the course of 2015, Water Saver Solutions shifted the data collection to digital flow meters that read in gpm. Hand- and foot-operated faucets were fully engaged for flow rate measurements. If a fully engaged hand- or foot-operated faucet produced too much flow to be considered reasonable for washing hands, the throttling controls (handles or pedals)

[6] Water Saver Solutions. 2012. Hot Water Fixture Flow Survey. "Hot Water Fixture Flow Survey Data WPSCGNRWH150827A.r2.xlsx." Conducted for the Southern California Gas Company.

were turned down until the surveyor believed a person could reasonably wash their hands without excessive splashing or overflow. This percentage of flow is used in the calculations as a behavioral factor of 0.7.

Faucet and adapter details were also recorded during data collection (e.g. types, uses, ideal operating flow rates).

Analysis and Results. The baseline flow rate of 2.7 gpm was calculated as the weighted average of the flow rate of approximately 4,000 faucets observed for the Water Saver Solutions study. This flow rate serves as a valid in situ baseline flow rate for existing health care facilities, excluding new construction. The observed faucets include varying quantities of hand, foot, and sensor operated faucet types.

As noted previously, a behavioral factor of 0.7 was applied to the hand and foot operated flow rates to account for human behavior in turning on the faucet, since not every operator will turn on the faucet to its full flow rate. Since sensor-operated faucets have no operator flow control, it was not considered necessary to add a behavioral factor to the measured flow rates.

CODE REQUIREMENTS

Code requirements pertaining to laminar flow restrictors are noted below. The California Appliance Efficiency Regulations (Title 20) specifies faucet flow rates as a code baseline.[7]

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2016)	Section 1605.3 (h), Tables H-3, H-4	January 1, 2017
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards	None.	n/a

NORMALIZING UNIT

Each.

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements. Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial

[7] California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations.* CEC-400-2017-002. Section 1605.3(h).

incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
Add-on equipment	DnDeemed	Ag
Add-on equipment	DnDeemed	Com
Add-on equipment	DnDeemed	Ind
Add-on equipment	DnDeemDI	Ag
Add-on equipment	DnDeemDI	Com
Add-on equipment	DnDeemDI	Ind

Eligible Products

Eligibility requirements for the laminar flow restrictor measure include:

- The device must be installed only in health care facilities that are subject to the Office of Statewide Health Planning and Development (OSHPD) code and regulation/inspection requirements.
- The device must meet the Office of Statewide Health Planning and Development (OSHPD) code and regulation.
- The LFR must be labeled as "Vandal Proof" or must not be removable without a proprietary tool, except for dialysis and scrub sink locations.

Eligible Building Types

Eligible building types for this measure are health care facilities and/or medical buildings of any vintage that adhere to the Office of Statewide Health Planning and Development (OSHPD) regulations in the State of California that also utilize natural gas-powered water heating equipment. These facilities include (but are not limited to):

- Hospitals (large regional or local)
- Emergency rooms
- In-patient and outpatient facilities and medical office buildings connected to or free standing from main hospitals
- Doctor offices (e.g. general practitioners, pediatricians, optometrists, chiropractors, etc.)
- Clinics and nursing homes

Eligible Climate Zones

The measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

New construction health care facilities are not eligible.

DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

USE CATEGORY

Service & Domestic Hot Water

ELECTRIC SAVINGS (kWh)

Not applicable.

PEAK ELECTRIC DEMAND REDUCTION (kW)

Not applicable.

GAS SAVINGS (Therms)

The gas unit energy savings (UES) of this measure is based upon the estimated decrease in hot water usage as a result of the installation of a laminar flow restrictor.

The savings calculation approach for this measure compares the unit energy consumption (UEC) of the base case service hot water (SHW) system of the existing condition (faucets without LFRs) with the UEC of the measure case condition (faucets with LFRs). The installation of a LFR will a change in the mass flow rate of water and thus ultimately affects the thermal load of the system.

Calculation of Water Usage and Water Savings

Water savings was calculated as the difference between the base case and measure case water usage.

$$WU = FlowRate \times Min \times Days$$

$$WS_{net} = WU_{base} - WU_{measure}$$

$WS =$	*Annual water savings (gal/yr)*
$WU =$	*Annual water use (gal/yr), for base or measure case*
$FlowRate =$	*Water volume flow rate (gpm), for base or measure case*
$Min =$	*Faucet average operating use time (min/day)*
$Days =$	*Faucet days of operation (days/yr)*

Water Usage Parameters

Parameter	Units	Base Case	Measure Case	Source
Flow Rate	gpm	2.7	Kitchen: 1.5 1.8 Lavatory: 0.5 1.0 1.2	-
Average Faucet Use Time	min/day	8	8	Water Saver Solutions. 2012. "Hot Water Fixture Flow Survey Data WPSCGNRWH150827A.r2.xlsx." Conducted for the Southern California Gas Company.
Operating Days	days/yr	308	308	See below.

Average Faucet Use Time. The average annual operating time per faucet was calculated as the median value of the 4-minute to 12-minute range developed by Water Saver Solutions from custom calculated data. A separate study by the Metropolitan Water District (MWD) found a similar average daily usage of ten minutes per faucet per day.[8]

Operating Days. The average days of operation per year for this measure analysis was calculated as the average of the operating days of clinics, hospitals, and nursing homes, weighted by the percent of the total estimated number of sinks represented by each facility type.[9] Operating days per year are based upon the assumption that clinics operate five days per week and nursing homes and hospitals operate seven days per week.

Derivation of Operating Days per Year

Building Type	# of Facilities (NAICS count)	Est. # of Sinks	Est. # of Sinks (rounded)	Operating Days/Year	% of Total Market (Based on Total # of Sinks)	Weighted Average Operating Days/Year
Clinic	12,000	187,897	200,000	260	54%	141
Nursing Home	2,000	66,501	70,000	365	19%	69
Hospital	800	97,200	100,000	365	27%	99
Total	**14,800**		**370,000**			**308**

Calculation of Gas Unit Energy Savings

The gas UES of this measure is based upon the estimated decrease in hot water usage, the efficiency rating of the water heating equipment, and the temperature differential between the make-up (ground) water and the water exiting the faucet.

[8] The source for this data or information is unknown.

[9] The source for this data or information is no longer available.

$$UES_{therms} = \left[\frac{WS \times Cp \times WaterWeight \times \left(\frac{1\ therm}{100{,}000\ Btu}\right)\left(T_{mixed} - T_{ground}\right)}{EFF_{gas}} \right]$$

UES_{therms} =	*Annual gas unit energy savings (therms/yr)*
WS =	*Annual water savings (gal/yr)*
Cp =	*Specific heat capacity of water (Btu/lb/°F), fixed constant*
WaterWeight =	*Weight of water (lb/gal), fixed constant*
T_{mixed} =	*Mixed water temperature, at faucet (°F)*
T_{ground} =	*Make-up groundwater temperature, (°F)*
EFF_{gas} =	*Water heater efficiency, gas*

The inputs and assumptions used in these equations are specified below

UEC Inputs

Parameter	Value	Source
Specific Heat Capacity of Water (Btu/lb/°F)	1	Fixed constant
Water Weight (lb/gal)	8.34	Fixed constant
Mixed Water Temperature @ Faucet Outlet (°F)	106 °F	Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".
Make-up Water Temperature (groundwater) (°F)	65 °F	Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".
Water Heater Thermal Efficiency (gas)	83%	California Public Utilities Commission (CPUC), Energy Division. 2020. "DEER-WaterHeater-Calculator-v4.2.xlsm." Updated September 17, 2020. Itron, Inc. and ERS, Inc. 2016. "2014 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report." Prepared for the California Public Utilities Commission. Itron, Inc. and ERS, Inc. 2017. 2015 Nonresidential Downstream Deemed ESPI Pipe Insulation Impact Evaluation Report. Prepared for the California Public Utilities Commission.

Make-up (Groundwater) Water Temperature. Make-up water(groundwater) temperature was derived from data collected from a field survey conducted for the Sempra Energy Utilities (San Diego Gas and Electric and the Southern California Gas Company) in 2009.[10]

Make-up (Groundwater) Water Temperatures by Climate Zone

Climate Zone	Make-up (Groundwater) Temperature (°F)	Source
CZ 1	51.4	Reeves, P. (Consultant to California Public Utilities
CZ 2	57.3	

[10] Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".

Climate Zone	Make-up (Groundwater) Temperature (°F)	Source
CZ 3	57.1	Commission, Energy Division). 2013. "Comparison-of-Ground-Temperatures-v2_byPaulReeves.xlsx."
CZ 4	59.5	
CZ 5	55.8	
CZ 6	61.8	
CZ 7	62.6	
CZ 8	63.7	
CZ 9	63.8	
CZ 10	64.2	
CZ 11	63.2	
CZ 12	60.9	
CZ 13	64.1	
CZ 14	62.7	
CZ 15	75.5	
CZ 16	51.8	

Mixed Water Temperature. Mixed water temperature was derived from data collected from a field survey conducted for the Sempra Energy Utilities (San Diego Gas and Electric and the Southern California Gas Company)in 2009.[11] Note that Section 613.5 of the California Plumbing Code[12] stipulates that "[t]emperature control valves shall be provided to automatically regulate the temperature of hot water delivered to plumbing fixtures used by patients to a range of 105 ˚F (41 ˚C) minimum to 120 ˚F (49 ˚C) maximum."

Water Heater Thermal Efficiency. The efficiency of a gas water heater was derived from data extracted from the California Energy Commission Water Heater Calculatorv4.1 in 2020. The average thermal efficiencies for all baseline water heater technologies was used and compared to the deemed pipe insulation evaluation conducted by Itron, Inc.

LIFE CYCLE

Effective Useful Life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining Useful Life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

As per Resolution E-4807, the California Public Utilities Commission (CPUC) defined the EUL of an add-on equipment measure as the minimum of the EUL of the measure itself and the RUL of the host equipment.[13] The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency

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[11] Sempra Energy Utilities (SEU). 2012. "SEU 2009 ASW Data REDACTED.xlsx".

[12] California Building Standards Commission. 2016. *California Code of Regulations. 2016 Title 24 Part 5, California Plumbing Code.* Section 613.5.

[13] California Public Utilities Commission (CPUC). 2016. *Resolution E-4807*. December 16. Page 13.

Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.” This approach provides a reasonable RUL estimate without the requiring any prior knowledge about the age of the equipment being replaced.[14] The RUL of the host equipment (a faucet for this particular measure) is therefore calculated as one-third of the EUL of a faucet.

Vandal-proof LFRs will allow installations to remain installed for their entire EUL. A vandal-proof LFR typically requires a proprietary tool to remove the device that prevents theft or deactivation.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs) - LFR	10.00	California Public Utilities Commission (CPUC), Energy Division. 2014. “DEER2014-EUL-table-update_2014-02-05.xlsx”
EUL (yrs) – host faucet	20.00	National Association of Home Builders (NAHB) / Bank of America Home Equity. 2007. *Study of Life Expectancy of Home Components.* Prepared by the Economics Group of NAHB. Page 12. Glacier Bay. (n.d.) “Glacier Bay Faucets 20-year Limited Warranty.”
RUL (yrs) – host faucet	6.67	California Public Utilities Commission (CPUC). 2016. *Resolution E-4807.* December 16. Page 13.

BASE CASE MATERIAL COST ($/UNIT)

Insofar as the laminar flow restrictor is *add-on equipment*, the base case assumes an existing faucet spout without a flow restriction device. Therefore, the base case cost is $0.

MEASURE CASE MATERIAL COST ($/UNIT)

The measure case equipment cost was calculated as the average of costs of vandal proof laminar flow restrictors obtained from the NEOPERL 2014 Wholesale Price List.[15] NEOPERL is a flow-control equipment wholesaler that provide aerators, sprays, laminar devices, check valves, and flow regulators.

BASE CASE LABOR COST ($/UNIT)

Insofar as the laminar flow restrictor is *add-on equipment*, the base case assumes existing faucet spout without a flow restriction device. Therefore, the base case labor cost is $0.

MEASURE CASE LABOR COST ($/UNIT)

The labor cost to install a laminar flow restrictor was based upon the (proprietary) negotiated contracted costs by a third party for a direct install program; the negotiated contract labor costs are proprietary, and documentation is not available.

[14] KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

[15] Southern California Gas Company (SCG). 2014. “LFR Price List 2014 WPSCGNRWH150827A.xlsx.”

The labor cost to install a laminar flow restrictor via a downstream rebate programs is $0.

NET-TO-GROSS (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The NTG value is based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. This sector average NTG ("default NTG") is applicable to all energy efficiency measures that have been offered through commercial sector programs for at least two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
NTG	0.60	Itron, Inc. 2011. *DEER Database 2011 Update Documentation.* Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current "default" rate specified for measures for which an alternative GSIA has not been estimated and approved.

Gross Savings Installation Adjustment Rates

Parameter	Value	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY BENEFITS

Non-energy impacts that result from the installation of a laminar flow restrictor is the reduction of water usage. Insofar as energy savings is a function of water savings, the calculation of water savings is explained in the Gas Savings section.

DEER DIFFERENCES ANALYSIS

The table below summarizes the inputs and methods that are and are not based upon the Database for Energy Efficient Resources (DEER). There is no DEER measure for the faucet LFRs. The most similar measure applicable for the LFR is the faucet aerator. However, LFRs are not traditional aerators since no outside air is introduced into the water stream.

The analysis for this measure includes the hot water consumption for faucets only, while the DEER results indicate the total hot water consumption for the buildings. The results from the DEER eQUEST models are more of an aggregate estimate and thus do not provide an accurate approximation for faucet hot water consumption.

DEER Difference Summary

DEER Item	Comment
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	No (but is referenced)
DEER Measure Case	No
DEER Building Types	Clinics, Hospitals, Nursing Homes
DEER Operating Hours	No
DEER eQUEST Prototypes	No
DEER Version	n/a
Reason for Deviation from DEER	DEER database does not contain this type of measure
DEER Measure IDs Used	n/a
NTG	The NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs*
GSIA	DEER. The GSIA value of 1.0 is associated with ID: *Def-GSIA*
EUL/RUL	The EUL of 10 years is associated with EUL ID: *WtrHt-WH-Aertr*

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision Effective Date and Approved By
01	03/31/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: Workpaper WPSCGNRWH150827A Revision #2 (April 8, 2016) Consensus reached among Cal TF members. Revision approval TBD. Effective date TBD.
	1/11/2019	Andres Marquez SCG	Update Delivery Type per DEER2019 Update Measure Application Type per DEER2019 Change NTG ID to measures in programs > 2 years
	1/31/2019	Jennifer Holmes Cal TF Staff	Revisions for version 01 submittal
02	10/7/2020	Anders Danryd SoCalGas	Updated water heater thermal efficiency to match baseline technologies in “Water Heater Calculator v4.2” per E-5082