



SERVICE AND DOMESTIC HOT WATER
PIPE WRAP, RESIDENTIAL
SWWH026-01

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MEASURE NAME

Pipe Wrap, Residential

STATEWIDE MEASURE ID

SWWH026-01

TECHNOLOGY SUMMARY

The addition of insulation to hot water and cold-water pipes, within the first 3 feet of a storage water heater in residential residences, adds thermal resistance and forces the heat flux to be reduced in magnitude. As a result, the fluid in the pipe system can retain its temperature due to a reduction in the heat loss gradient. Keeping the hot lines warmer and the cold lines colder will allow the storage water heater to offset its energy demand and reduce its energy consumption.

SoCalGas's Res-Direct Install (Res-DI) program found many opportunities for pipe insulation on several feet of exposed hot and cold piping coming out of existing residential water heaters. From February 2019 – March 2019, Res-DI contractors collected data and took photos of homes where pipe wrap was feasible. A total of 93 homes were inspected, and 60% of them did not have existing pipe insulation on the water lines coming from the water heater into the adjacent wall. There was on average 3.6 feet of exposed pipe for each water line.

Lab tests were also performed within SoCalGas's water heating demo lab to further show the potential for energy savings of this technology. SoCalGas Engineering Services attached thermocouples to measure the temperature about various areas of an idle water heater. Using the data¹ collected, SoCalGas found that there is opportunity to reduce heat loss in both the hot and cold-water lines while the water heater is idling by adding insulation. Line temperatures while idle were significantly above ambient temperature, about 10 °F.

MEASURE CASE DESCRIPTION

The measure case is defined as the installation of minimum 1 inch insulation to an existing bare pipe system on a storage water heater as described in the Technology Summary section. Specifications are established by pipe diameter and assume 1 inch insulation. Note that savings are calculated for each measure offering by building type and by climate zone.

¹ Residential Pipe Wrap Analysis.xls

BASE CASE DESCRIPTION

The base case is defined as existing bare (un-insulated) pipe within the first 3 feet of both hot water and cold-water supply lines connected to a storage water heater at single family, multi-family and mobile home residences.

CODE REQUIREMENTS

Applicable federal and state codes are shown in the table below. The application of the pipe insulation to hot fluid piping, as required by the 2016 California Building Energy Efficiency Standards (Title 24)² and the federal Occupational Safety and Health Administration (OSHA) Standard³ does not apply to this measure.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
California Plumbing Code	none	n/a
CA Building Energy Efficiency Standards – Title 24	none	n/a
Federal Standards	none	n/a

Section 609.11 of the California Plumbing Code specifies requirements for pipe insulation, shown below. However, this requirement is for newly constructed residences. This measure is classified as add-on equipment for existing bare (un-insulated) pipes within the first 3 feet of both hot water and cold-water supply lines connected to a storage water heater and therefore does not trigger California Plumbing Code compliance.

Residential Compliance Manual ⁴

“All domestic hot water piping shall be insulated as specified in Section 609.11 of the California Plumbing Code, which requires pipe insulation thickness equal to or more than the diameter of the pipe, up to 2 inches. Above pipe diameter of 2 inches, the insulation thickness must be at least 2 inches. In addition, the following piping conditions shall have a minimum insulation wall thickness of 1 inch:

- 1. The first 5 feet of hot and cold-water pipes from the storage tank or water heater.*
- 2. All piping with a nominal diameter of ¾ inch or larger.*
- 3. All piping associated within a domestic hot water recirculation system regardless of the pipe diameter. This excludes branches off the recirculation loop that are less than ¾ inch diameter or do not serve the kitchen.*
- 4. Piping from the heating source to a storage tank or between tanks.*
- 5. Piping buried below grade.*
- 6. All hot water pipes from the heating source to the kitchen fixtures.”*

NORMALIZING UNIT

Each

² California Energy Commission (CEC). 2015. 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings. CEC-400-2015-037-CMF

³ Code of Federal Regulations at 29 CFR 1910.261

⁴ 2016 Residential Compliance Manual, section 5.3.5

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 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	DnDeemDI	Res

Eligible Products

Program eligibility requirements for the addition of insulation to hot water and cold-water pipes, within the first 3 feet of a storage water heater include:

- A minimum of 1 inch of pipe insulation must be added to existing bare pipe
- Acceptable types of insulation for hot water pipes include elastomeric foam rubber, polyethylene foam, UV-resistant polyethylene foam, and rigid polyurethane foam.
- Must be direct install by an authorized implementer.
- Verification of no existing pipe insulation
- Unconditioned garage spaces are considered “indoor” installations

Eligible Building Types and Vintages

The measure is applicable for any existing residential building types and all vintages.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

The following conditions are excluded:

- This measure is not applicable for commercial or industrial applications.
- This measure is not eligible for new construction applications as defined by the California Plumbing Code.

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)

Methodology

The annual gas unit energy savings (UES) of this measure is the result of reduced heat losses in both hot water and cold-water lines and the reduced heating load on the connected gas-fired equipment. The annual gas UES are calculated as the difference in heat losses between the uninsulated pipe (base case) and the insulated surface (measure case). The average water heater Uniform Energy Factor (UEF) was then factored in to translate the reduced heat losses from the uninsulated pipe into the reduced gas consumption of the water heater.

The annual energy saved by pipe insulation can be calculated as the following:

$$UES_{gas} = \frac{HOURS \times (Q_b - Q_i)}{100,000 \times UEF} \times Pipeft$$

UES_{gas} = Annual gas unit energy savings (in therms)

$HOURS$ = Annual operating hours

Q_b = Heat Loss from Bare pipe (Btu/hr/ft²)

Q_i = Heat Loss from Insulated pipe (Btu/hr/ft²)

UEF = Uniform Energy factor of water heater

$Pipeft$ = Length of pipe to be insulated (ft)

$100,000$ = Conversion factor (1 therm = 100,000 Btu)

Inputs and Assumptions

Annual Operating Hours. The actual draw time from the DEER-WaterHeater-Calculator-v3.3⁵ is negligible for this application therefore the hours of operation are assumed to be 8,760 hrs.

Heat Loss. The heat loss calculations were performed using industry-accepted software from the North American Insulation Manufacturers Association (NAIMA). The NAIMA 3E Plus v4.1 software uses the

⁵ DEER-WaterHeater-Calculator-v3.3

calculation methodology from the American Society for Testing and Materials (ASTM). The heat loss is simply the total heat loss due to the exposed pipe maintaining a constant temperature due to conduction heating of the pipe from water heater.

Storage Water Heater Efficiency⁶. To convert reduced heat losses from the pipes into energy savings of the water heater, the UEF of the water heater needs to be considered. The UEF used is the minimum UEF as described in statewide workpaper SWWH012 Storage Water Heater, Residential.

Heat Loss Calculation Inputs for Hot Water Pipe

Input	Base Case	Measure Case	Source
Surface	Bare	Insulated	n/a
Pipe Material	Steel (Steel is the most common material for residential applications) Emittance = 0.8		Professional judgment for typical applications
Pipe length	6 ft total. 3 on both hot and cold water line		SoCalGas’s Res-Direct Install (Res-DI) program
Pipe Diameter	¾ inch		Most typical size
Insulation Material	Bare	1” closed cell polyethylene foam insulation	Professional judgment for typical residential applications
Annual Operating Hours	8,760		
Process Temperature (°F inside the pipe)	100 °F		Average temperature between hot water and cold water pipes after draw is complete “Residential Pipe Wrap Analysis.xls”
Annual average dry-bulb temperature (°F)	Varies by climate zone		California Energy Commission (CEC). 2012. 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24): Reference Appendices. CEC-400-2012-005-CMF-REV3. Appendix JA2.
Wind Speed (mph)	Varies by climate zone. Each monthly average Wind Speed was adjusted for the proper height at the plant (30% of the speed in the weather file) since weather station wind measurements are at heights of 10 to 30 feet		California Energy Commission (CEC). 2012. 2013 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24): Reference Appendices. CEC-400-2012-005-CMF-REV3. Appendix JA2. Professional judgment for typical applications
Ambient Conditions – Indoor pipe	Air temperature: 75 °F Wind speed: 0 mph.		
Water Heater UEF	0.64		SWWH012-01, Storage Water Heater, Residential

⁶ SWWH012-01, Storage Water Heater, Residential

The temperature-dependent thermal conductivity of the fiberglass assumed in the 3E Plus software is shown in below.

1" closed cell polyethylene foam Insulation Thermal Conductivity⁷

Temperature (°F)	Thermal Conductivity (Btu-in/hr-ft ² -°F)
50	0.265
75	0.27
100	0.28

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.

The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency 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."⁸ This approach provides a reasonable RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.⁹ Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised add-on measures so that the EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component."¹⁰

The EUL and RUL specified for pipe insulation are specified below. Note that the RUL of the host water heater complies with Resolution E-4952, which stipulated host equipment RUL values for add-on equipment measures.

⁷ Imcoa_SS_WSS_Sheet_and_Roll.Sub.EN.US.2019.pdf

⁸ California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

⁹ KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

¹⁰ California Public Utilities Commission (CPUC). 2016. Resolution E-4807. December 16. Page 13.

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs) – Residential Pipe Wrap	11.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
EUL (yrs) – Host Pipe	20.0	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs) – Host Pipe	6.7	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."

BASE CASE MATERIAL COST (\$/UNIT)

The base case material cost for the measure is \$0.

MEASURE CASE MATERIAL COST (\$/UNIT)

The measure case material cost information will stem from the RSMeans Green Building Cost Data 2014 using a 1 inch closed cell polyethylene foam insulation installed on a ¾ inch pipe. The material cost per linear foot is \$0.49.

BASE CASE LABOR COST (\$/UNIT)

The base case labor cost is \$0.

MEASURE CASE LABOR COST (\$/UNIT)

Measure labor cost information will stem from the RSMeans Green Building Cost Data 2014. The labor cost per linear foot is \$3.53.

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 residential programs, as documented in the 2011 DEER Update Study conducted by Itron, Inc. These sector average NTGs ("default NTGs") are applicable to all energy efficiency measures that have been offered through residential sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value	Source
NTG – All-Default<=2yrs	0.7	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . 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.

Gross Savings Installation Adjustment

Parameter	GSIA	Source
GSIA – Def-GSIA	1	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . Page 31.

NON-ENERGY IMPACTS

Non-energy benefits for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment
Modified DEER methodology	Yes
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	No
DEER Version	
Reason for Deviation from DEER	Deer Does Not contain this type of measure
DEER Measure IDs Used	NA
NTG	Source: Itron ESPI Pipe Insulation Report. NTG of 0.7 is associated with NTG IDs: All-Default<=2yrs
GSIA	Source: Itron ESPI Pipe Insulation Report. The GSIA of 1 is associated with GSIA ID: Def-GSIA
EUL/RUL	Source: The value of 20years is associated with EUL ID: WtrHt-WH-R4PipeIns-Gas.RUL ID: WtrHt-WH-R4PipeIns-Gas (proposed)

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	12/02/2019	Jaime Lopez SoCalGas	New Workpaper
	02/07/2019	Andres Marquez SoCalGas	Minor edits per “CPUC Comments 01/21/2019, SWWH026-01 Residential Pipe Wrap”
	05/27/2020	Eduardo Reynoso, SDG&E	Workpaper measure adoption by SDG&E, no changes to energy efficiency savings or cost. Updated Ex-ante Implementation data table. No other changes.
	03/30/2021	Soe K Hla PG&E	Adopted all measures for PG&E. Fixed incorrect GSIA ID from Res-Ins-All to Def-GSIA