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HVAC

INTERMITTENT PILOT LIGHT, RESIDENTIAL

SWHC002-02

CONTENTS

MEASURE NAME

Intermittent Pilot Light, Residential

STATEWIDE MEASURE ID

SWHC002-02

TECHNOLOGY SUMMARY

The measure pertains to intermittent pilot light (IPL) controls that are added to existing furnaces (including but not limited to gravity, direct vented, top vented, and fan assisted), fireplace inserts, or are manufactured into a new gravity wall furnace.

IPL controls will turn the pilot light ON and OFF depending on the furnace or fireplace insert heat demand status. The control valves turn the pilot light OFF when the furnace burners are off due to the furnace not being triggered for heat. During heat demand, the ignition module opens the pilot valve and initiates a spark at the pilot head to turn the pilot light on. The spark is created from a voltage delivered by the module battery or voltage line from the wall. Once on, the pilot light continues with the normal operation of turning on the burners. Once the heat demand is satisfied, the pilot light valve will close and wait for the next cycle.

Restricting the pilot light to only operate during times of heat demand reduces the gas energy consumption and yields energy savings. The *High Efficiency Natural Gas Wall Furnace Field Evaluation* (2013) conducted for the Southern California Gas Company (SCG) Emerging Technologies Program,[1] reports that a pilot light consumes approximately 3.7 therms to 7.2 therms per month depending on the furnace efficiency. This study further states that pilot energy intensity accounts for 62% of the annual energy consumed by a baseline furnace.

The field study replaced the wall furnace in three different studio housing type units and gathered empirical energy consumption data. Measure case, high-efficiency furnace units had an input rating of 25,000 Btu/hr and 71% AFUE. Baseline furnaces had an AFUE of approximately 63%. The potential savings from a higher efficiency furnace (in the SCG territory) is estimated to be 169,750 therms per year for multifamily residences; and 162,750 therms per year for a single-family residence. The field Study states the pilot light is the most significant consumer of gas and estimated that the pilot lights account for half the savings. The study recommends "[*u*]*tility programs may want to consider the elimination of standing pilots when developing rebate requirements."*

These results indicate there is ample opportunity for energy savings from the elimination of standing pilot lights in wall furnaces and fireplaces.

[1] NegaWatt Consulting, Inc. 2013. *High Efficiency Gas Wall Furnace Field Evaluation. Southern California Gas Company, Emerging Technologies Assessment Report.* Project ID E12SCG0018. Prepared for the Southern California Gas Company. July 25.

MEASURE CASE DESCRIPTION

The measure case is defined as intermittent pilot light (IPL) controls that will turn off the gravity wall furnace pilot light during times of no heat demand. The measure offerings are:

- The installation of IPL controls in an existing wall furnace or fireplace (add-on equipment)
- IPL controls integrated in a new high-efficiency gravity wall furnace (new construction)

Note that the savings for the new construction measure offering represent the savings associated with the IPL controls only, and do not represent the savings due to the installation of a high-efficiency furnace.

BASE CASE DESCRIPTION

The base case is defined as a wall furnace with a continuous pilot light.

CODE REQUIREMENTS

The California Appliance Efficiency Regulations (Title 20) requires wall furnaces to meet certain efficiencies, however it does not require pilot light controls. The California Building Energy Efficiency Standards (Title 24) includes stringent requirements for furnace pilot lights, however the requirements do not apply to wall furnaces. Both Title 20 and Title 24 standards that relate, but are not applicable to, this measure are provided below for informational purposes.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2016)	Title 20 Section 1605.1(e)(1)	April 16, 2013
CA Building Energy Efficiency Standards – Title 24 (2019)	Title 24 Sections 110.5 and 150.0 (e)(2)	January 1, 2020
Federal Standards	None.	n/a

Title 20 requirements for wall furnaces are specified in Table E-2 below.[2]

[2] California Energy Commission (CEC). 2017. *2016 Appliance Efficiency Regulations*. CEC-400-2017-002. Section 1605.1(e)(1).

Table E-2
Standards for Gas Wall Furnaces, Floor Furnaces, and Room Heaters

Appliance	*Design Type*	*Capacity (Btu per hour)*	*Minimum AFUE (%)*	
			Effective Before April 16, 2013	*Effective On or After April 16, 2013*
Wall furnace	Fan	≤ 42,000	73	75
Wall furnace	Fan	> 42,000	74	76
Wall furnace	Gravity	≤ 10,000	59	65
Wall furnace	Gravity	> 10,000 and ≤ 12,000	60	
Wall furnace	Gravity	> 12,000 and ≤ 15,000	61	
Wall furnace	Gravity	> 15,000 and ≤ 19,000	62	
Wall furnace	Gravity	> 19,000 and ≤ 27,000	63	
Wall furnace	Gravity	> 27,000 and ≤ 46,000	64	66
Wall furnace	Gravity	> 46,000	65	67

Section 110.5 of Title 24 stipulates:

> *Any natural gas system or equipment listed below may be installed only if it does not have a continuously burning pilot light:*
> *(a) Fan-type central furnaces.*
> *(b) Household cooking appliances.*
> ***EXCEPTION to Section 110.5(b):** Household cooking appliances without an electrical supply voltage connection and in which each pilot consumes less than 150 Btu/hr.*
> *(c) Pool heaters.*
> *(d) Spa heaters.*
> *(e) Indoor and outdoor fireplaces.*

Title 24 stipulates requirements for fireplaces, as shown below.[3] However, the IPL control is an add-on application; therefore, it qualifies as a fireplace unit in existing vintages with a standing pilot light.

> ***Installation of Fireplaces, Decorative Gas Appliances and Gas Logs.** If a masonry or factory-built fireplace is installed, it shall comply with Section 110.5, Section 4.503 of Part 11, and shall have the following:*
> *1. Closeable metal or glass doors covering the entire opening of the firebox; and*
> *2. A combustion air intake to draw air from the outside of the building, which is at least 6 square inches in area and is equipped with a readily accessible, operable, and tight-fitting damper or combustion-air control device; and*
> ***EXCEPTION to Section 150.0(e)1B:** An outside combustion-air intake is not required if the fireplace will be installed over concrete slab flooring and the fireplace will not be located on an exterior wall.*

NORMALIZING UNIT

Each.

[3] California Energy Commission (CEC). 2018. *2019 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24).* CEC-400-2018-020-CMF.Section 150.0 (e)(2).

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
New construction	DnDeemed	Res
New construction	DnDeemDI	Res
New construction	UpDeemed	Res
Add-on equipment	DnDeemed	Res
Add-on equipment	DnDeemDI	Res
Add-on equipment	UpDeemed	Res

Proof of purchase of a gravity wall furnace manufactured with an integrated intermittent pilot light must be provided.

The customer must agree to a post installation inspection.

Eligible Products

Eligibility requirements for this measure are:

- This measure pertains to gravity wall furnaces manufactured with integrated IPL controls, furnaces with a standing pilot light, and any fireplace with standing pilot light.
- A furnace manufactured with integrated IPL controls can only replace a gravity wall furnace.
- The IPL controls shall be capable of either using a battery or voltage line to effectively operate as intended.

Implementation and installation requirements are:

- For *direct install installations*, the wall furnace or fireplace insert shall be functional prior to the IPL retrofit.
- For *direct install installations*, the IPL control cannot replace an existing functional or non-functional pilot light control on a furnace or fireplace insert.
- Any technology manufacturer qualifies for measure offerings specified, if safety and all other regulations are met and the technology is commercially available.

Eligible Building Types and Vintages

This measure is applicable for all existing single-family and multifamily residences of any vintage.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

Used or rebuilt equipment is not eligible.

DATA COLLECTION REQUIREMENTS

The quality of the data utilized for this measure analysis is appropriate for computational purposes. Primarily, the data was used to establish the precedent of energy loss of a standing pilot light as well as the energy consumption of the pilot light. A future data need is a baseline study to develop a richer estimate of the annual hours that the pilot is on for both base case and measure case scenarios.

USE CATEGORY

HVAC

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 a function of the pilot light usage and efficiency; and the gas furnace usage and efficiency. Pilot light usage, or the portion of total annual hours that a pilot light is ON, is determined from an analysis of weather data, customer inquiries to turn their pilot light ON/OFF during the year, and analysis results of the unit energy consumption (UEC) and UES of a gravity wall furnace.

The following equations compute the energy demand by the furnace. A summary of the inputs follows.

$$T_{on} = \frac{\left(\frac{HDD \times P}{Area \times C} \times A\right) \times \frac{100{,}000\ Btu}{1\ Therm}}{A}$$

$$E_{pilot\ light\ savings} = \sum_{T_{on}=1}^{8760} \left[[1 - (T_{on})] \times PI\right] \times \eta,)$$

$T_{on}=$ *Fraction of the hour the furnace is ON with HDD*
$E_{pilot\ light\ savings}=$ *Energy saved by intermittently turning pilot light ON*
$HDD=$ *Heating degree days*
$P=$ *Gravity wall furnace regression coefficient (Therm/HDD*home)*[4]
$Area=$ *Home area (ft^2),*
$C=$ *Furnace input (Btu/hr ft²)*
$A=$ *Furnace capacity, (Btu/hr)*
$PI=$ *Pilot light hourly heat rate (Btu/hr)*
$\eta=$ *Pilot light efficiency (%)*

UES Inputs

Input	Value	Source
Pilot Light Efficiency	33%	California Public Utilities Commission (CPUC), Energy Division. 2017. DEER2015 Small Storage and Small Instantaneous Water Heater Energy Use Calculator. "DEER-WaterHeater-Calculator-v2.1.xlsm." Updated July 10, 2017.
Pilot light hourly heat rate (Btu/hr)	501.42	Southern California Gas Company (SCG). 2018. "IPL Energy Savings Analysis 2018 .xlsx"
Heating degree days, HDD (base of 65 °F)	*Varies by climate zone*	Southern California Gas Company (SCG). 2018. "IPL Energy Savings Analysis 2018 .xlsx" See "IPL_REA Savings" tab. Southern California Gas Company (SCG). 2013. "WPSCGREHC180723A-Rev00_Intermittent Pilot Light_Att C_CompareWeatherData-v4.xlsm." July 3.
Home area – single family (ft^2)	1,366	Southern California Gas Company (SCG). 2014. "WPSCGREHC110603A.2 2013 Analysis 012014.xlsx." January 20. See "Raw+Swft" tab.
Home area – multifamily (ft^2)	950	Southern California Gas Company (SCG). 2014. "WPSCGREHC110603A.2 2013 Analysis 012014.xlsx." January 20. See "Raw+Swft" tab.

Fraction of the hour that the furnace is ON due to HDD. The savings for this measure were computed by assessing the hours per year the standing pilot is ON and OFF, this was accomplished by utilizing the SCG data of customer calls for pilot ignition and to turn the pilot OFF. The data revealed that customers called SCG to turn OFF pilot lights throughout the year, however the intensity of calls is highest from April to July, with the maximum number of calls received in July. Due to July experiencing the highest call volume, July is considered to be the month when pilot lights are turned OFF.

[4] Southern California Gas Company (SCG). 2013. "WPSCGREHV110603A_2013_Wall_Furnace_Results-Rev2.xlsx."

The same process was followed to determine the month when pilot lights are turned ON; the months with the highest intensity were from October through January, with the maximum number of calls received in December. December is considered to the month when pilot lights are turned ON.

Since pilot lights are turned ON in December and turned OFF in July, the pilot lights are ON for seven months and of OFF for five.

Using weather data approved by the California Public Utilities Commission (CPUC),[5] the annual ON and OFF hours are identified from the 8760 annual hours available. The ON hours are found to be from hours #1-4344 and hours #8017-8760; hours #4345-8016 are determined to be OFF hours.

Savings will not occur during OFF hours.

Energy savings will occur during the ON hours. There are two scenarios for ON hours that will yield savings, these instances depend on the hourly heating degree day (HDD):

1. During an ON hour and if the HDD = 0, the savings are equal to the entire pilot light hourly heat rate.
2. During an ON hour and if HDD is > 0, the fraction of the hour that the furnace is ON is computed and the OFF fraction is multiplied by the pilot light hourly heat rate.
3. During an ON hour and if the HDD is > 0, the pilot light efficiency must be accounted for in the calculation. Pilot light efficiency represents the amount of heat produced from the pilot light that is transferred to the conditioned space. Currently there are no studies that have assessed this value, however, the DEER water heater calculator[6] uses a pilot light efficiency of 67%. Thus, this measure for this instance will only claim 33% (1 minus pilot light efficiency) of the energy as savings that would have otherwise been losses. In other words, 67% of the pilot heat rate is assumed to be transferred into the conditioned space.

Pilot Light Hourly Heat Rate. The pilot light hourly heat rate was drawn from an Emerging Technologies study that tested the functionality of battery-driven IPL controls.[7]

Sample Calculation

For climate zone 9, for hour #7 for a single-family dwelling with a wall furnace rated at 25 kBtu/hr, the HDD has a value of 1.17. Hour #7 falls under on hours as described above. First the fraction of the hour the furnace shall be on to compensate for the HDD heat demand shall be estimated by equation 1.

$$T_{on} = \frac{\left(\frac{1.17 * 0.1310}{1366 * 30} * 25{,}000\right) * \frac{100{,}000\ Btu}{1\ Therm}}{25{,}000} = 0.37$$

[5] Southern California Gas Company (SCG). 2013. "WPSCGREHC180723A-Rev00_Intermittent Pilot Light_Att C_CompareWeatherData-v4.xlsm." July 3.

[6] California Public Utilities Commission (CPUC), Energy Division. 2017. DEER2015 Small Storage and Small Instantaneous Water Heater Energy Use Calculator. "DEER-WaterHeater-Calculator-v2.1.xlsm." Updated July 10, 2017.

[7] NegaWATT Consulting, Inc. 2013. *High Efficiency Natural Gas Wall Furnace Field Evaluation.* Emerging Technologies Program Assessment Report Project ID E12SCG0018. Prepared for Southern California Gas Company (SCG).

Southern California Gas Company (SCG). 2018. "Gravity Wall Furnace Baseline Test.xlsx."

Thus, the furnace shall be ON for 0.37 fraction of one hour to compensate the heat demand by the 1.17 HDD in hour #7.

Then, the UES from an intermittent pilot light for this scenario is calculated as

$$E_{pilot\ light\ savings} = \left[[1 - (0.37)] * 501.4\right] * .33 = 104.2\ Btu$$

This calculation was completed 8760 times to compute all annual hours for single-family and multifamily homes.

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 prior 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 equipment 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 this measure are presented below are based upon the estimated lifetime of HVAC energy management system lifetime (as a proxy for the lifetime of the IPL controls) and the estimated lifetime of a gravity wall furnace (the host equipment). Due to the nature of the relatively austere design of wall furnaces, the estimated lifetime is expected to exceed 20 years. Since EUL of gravity wall furnaces are not available from the Database of Energy Efficient Resources (DEER), the estimated life of a high efficiency gas furnace is adopted for this measure. The high efficiency furnace EUL was updated in 2008 and assumed the maximum EUL, as stipulated in the *Energy Efficiency Policy Manual,* which *states, "[i]n order to minimize uncertainty, EULs will be limited to a maximum of 20 years, even if particular devices may be expected to survive longer."*

[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) – Host, gravity wall furnace	20.00	California Public Utilities Commission (CPUC). 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx." California Public Utilities Commission (CPUC), Energy Division. 2008. "EUL_Summary_10-1-08.xls." California Public Utilities Commission (CPUC), Energy Division. 2003. *Energy Efficiency Policy Manual v 2.0. Page 16.*
EUL (yrs) –Measure, IPL controls	15.00	California Public Utilities Commission (CPUC), Energy Division. 2003. *Energy Efficiency Policy Manual v 2.0.* Table 4.1 Page 17.
RUL (yrs)	6.67	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

BASE CASE MATERIAL COST ($/UNIT)

The base case material cost for add-on equipment installation is $0, since the base case is defined as the existing furnace with a continuous pilot light.

The base case material cost for IPL controls integrated with a new gravity wall furnace is equal to the cost of a gravity wall furnace manufactured without IPL controls. The base case costs were calculated as the average cost for each input size from list prices obtained from online retailers in August of 2018.[11]

MEASURE CASE MATERIAL COST ($/UNIT)

IPL Controls Only. There are currently only a few manufacturers of intermittent pilot light technologies. The cost of IPL controls includes both voltage line and battery powered to estimate an accurate equipment cost. The IPL controls cost was estimated as the average unit cost of IPLs recorded from online product suppliers and retailers and discussions with product manufacturers in August of 2018.

Measure Case Material Cost Inputs

Unit	Manufacturer	Model #	Cost ($)[12]
Pilot Ignitor System	Manufacturer A	Model 1	$168.00
Pilot Ignitor System	Manufacturer A	Model 2	$199.00
Pilot Ignitor System	Manufacturer B	Model 3	$290.36
Pilot Ignitor System	Manufacturer C	Model 4	$350.95
Pilot Ignitor System	Manufacturer B	Model 5	$229.95
Pilot Ignitor System	Manufacturer D	Model 6	$350.00

[11] Southern California Gas Company (SCG). 2018. "IPL Energy Savings Analysis 2018 .xlsx" See 'Cost Analysis' tab.

[12] Southern California Gas Company (SCG). 2018. "IPL Energy Savings Analysis 2018 .xlsx" See 'Cost Analysis' tab.

IPL Controls Integrated in Gravity Wall Furnace Unit. A gravity wall furnace manufactured with integrated IPL controls includes an incremental cost above the cost of a furnace of the same capacity *without* IPL controls. Thus, the material cost of this measure offering is calculated as the sum of the incremental cost of integrated IPL controls and the cost of a high-efficiency gravity wall furnace that meets the requirements of the high efficiency gravity wall furnace measure.

BASE CASE LABOR COST ($/UNIT)

The base case is an existing or new gravity wall furnace without IPL controls, thus the base case labor cost is equal to $0.

MEASURE CASE LABOR COST ($/UNIT)

IPL Controls Only. The measure case installation labor cost to retrofit an existing furnace with IPL controls was calculated as the product of the assumed labor rate and the estimated time required to retrofit a wall furnace by a highly trained and adept technician. The labor rate is the miscellaneous labor rate adopted for the Database of Energy Efficient Resources (DEER).

IPL Controls Integrated in Gravity Wall Furnace Unit. The installation labor cost to install this measure offering was the calculated as the product of the assumed labor rate and the estimated time required to install a new gravity wall furnace with integrated IPL controls.

Measure Case Labor Cost Inputs

Input	Value	Source
Hourly labor rate ($/hour)	$67.88	Keneipp, F. and M. Yim. (Summit Blue Consulting, LLC). 2008. *2008 DEER Measure Cost Documentation*.
IPL controls-only installation labor (hours)	0.667	Professional judgement.
Gravity wall furnace with integrated IPL controls installation labor (hours)	3.0	Professional judgement.

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 adopted for this measure was established in the 2011 DEER Update Study conducted by Itron, Inc. and is 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
Res-Default>2	0.55	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	GSIA	Source
GSIA	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY IMPACTS

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

DEER DIFFERENCES ANALYSIS

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based.

DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	No
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	DEER READI v.2.5.1 (2021)
Reason for Deviation from DEER	DEER does not contain this type of measure.
DEER Measure IDs Used	n/a
NTG	The NTG of 0.55 is associated with NTG ID: *Res-Default>2*
GSIA	The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	The value of 6.67 years is equal to 1/3 of the host wall furnace EUL ID: *HV-EffFurn*. The EUL ID *HVAC-EMS* is used as a proxy for the lifetime of IPL controls.

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	09/30/2018	Jennifer Holmes, Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: WPSCGREHC180723A, Revision 0 (August 16, 2018) Consensus reached among Cal TF members.
	04/26/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.
	04/09/2021	Anders Danryd, SoCalGas	Changed load shape to *DEER:HVAC_Eff_HP* in order to satisfy avoided cost combo validation in the CET
02	04/26/2021	Andres Marquez, SoCalGas	Update Net-to-Gross (NTG) from *ET-Default* to *Res-Default>2* as the measures have been offered in the marketplace for 2 years Added missing delivery types to *Implementation Eligibility* table and EAD implementation tab