Workpaper WPSCGNRHC140815A
Revision 0

Southern California Gas Company
Customer Programs Department

High Efficiency Commercial Gas-Fired Unit Heaters

August 15, 2014

Revision History

Revision No.	Date	Description	Author
0	09/22/2014	Initial draft	Jim Young, Navigant Chan Paek, SCG

Measure Summary Table A

Measure ID	Measure Description	Pre-Existing Description	Code/Standard Description	Sector	App Type(s)	Delivery Meth-od(s)	EUL ID	NTG ID(s)	GSIA ID
1	High Efficiency Unit Heaters, >= 90% TE	NA	Unit Heaters, =80% TE	Non-Res	ROB NC	PreRebate	HVAC-Frnc	All-Default <=2yrs	Def-GSIA
2	High Efficiency Unit Heaters, >= 90% TE	Unit Heaters, =80% TE	Title 20 (2014) Sec 1605.1(e)	Non-Res	ROB NC	PreRebate	HVAC-Frnc	All-Default <=2yrs	Def-GSIA
3	High Efficiency Unit Heaters, >= 90% TE	Unit Heaters, =80% TE	Title 20 (2014) Sec 1605.1(e)	Non-Res	ROB NC	PreRebate	HVAC-Frnc	All-Default <=2yrs	Def-GSIA
17	High Efficiency Unit Heaters, >= 90% TE	Unit Heaters, =80% TE	Title 20 (2014) Sec 1605.1(e)	Non-Res	ROB NC	PreRebate	HVAC-Frnc	All-Default <=2yrs	Def-GSIA
18	High Efficiency Unit Heaters, >= 90% TE	Unit Heaters, =80% TE	Title 20 (2014) Sec 1605.1(e)	Non-Res	ROB NC	PreRebate	HVAC-Frnc	All-Default <=2yrs	Def-GSIA

Measure Summary Table B

Measure ID	Descriptors					Above Preexisting/ Customer-Average Savings			Above Code/ Standard Savings			Cost		
	Bldg Type	Bldg Vint	Bldg Loc	Bldg HVAC	Norm Unit	kWh/ unit	kW/unit	therm	kWh/ unit	kW/unit	therm	Code/ Standard ($/unit)	Measure ($/unit)	Incremental Measure ($/unit)
1	COM	ANY	CZ1	aGF	kBtuh				0	0	1.02	$7.17	$19.31	$12.14
2	COM	ANY	CZ2	aGF	kBtuh				0	0	0.68	$7.17	$19.31	$12.14
3	COM	ANY	CZ3	aGF	kBtuh				0	0	0.56	$7.17	$19.31	$12.14
17	COM	ANY	SCG	aGF	kBtuh				0	0	0.29	$7.17	$19.31	$12.14
18	COM	ANY	CA	aGF	kBtuh				0	0	0.38	$7.17	$19.31	$12.14

Note: For the complete list of Measures, refer to Attachment A -.

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SECTION 1 - GENERAL MEASURE & BASELINE DATA

1.01 MEASURE & DELIVERY DESCRIPTION

A. Measure Description

1. This workpaper documents the program analysis of the High Efficiency Commercial Gas-Fired Unit Heaters measure, as determined through the Portfolio of the Future (POF) program at Southern California Gas Company.

   Space heating accounts for 36.4%[1] of natural gas energy consumption for commercial buildings in California, and up to 73%[2] for other buildings where water heating is not a major load such as warehouses. For many buildings where space cooling is not required, non-centralized equipment such as unit heaters provide space heating loads for these semi-conditioned spaces, including warehouses, distribution facilities, garages, loading docks, etc. Unit heaters supply upwards of 65% of commercial floor space nationally, resulting in 18% of total commercial gas-fired heating[3]. As discussed in the following sections, natural gas consumption by gas-fired unit heaters can be reduced by an average of 11.1% by replacing a conventional gas-fired unit heater with a high efficiency gas-fired unit heater.

   High efficiency gas-fired unit heaters reduce natural gas consumption while maintaining heating performance by increasing the natural gas combustion efficiency, reducing off-cycle heating losses, and/or transferring the latent heat of flue gases to the building space. By using strategies such as intermittent ignition devices, separated combustion, power venting, and condensing heat exchangers, high efficiency gas-fired unit heaters offer increased steady-state thermal efficiency and seasonal efficiency over conventional unit heaters.

   This technical workpaper documents the natural gas savings offered by condensing unit heaters. These space heating products can be readily retrofit into existing buildings as a replacement for conventional unit heaters, or as an alternative for new construction, if condensate drainage can be accommodated. This technical workpaper estimates the cost and energy savings potential under these new specifications within the Southern California Gas Company's (SCG) territory and each Title 24 climate zone.

2. Non-Centralized Gas-Fired Space Heating Equipment Classification

   a. Non-centralized gas-fired space heating equipment is classified based on the type of combustion process, how heat from the combusted natural gas reaches the space, and how the exhaust gases are handled. There are three general categories of non-centralized gas-fired space heating equipment: unit heaters, direct-fired heaters, and infrared heaters. Various subcategories exist within these three general groups, but are for specific applications and do not differ in performance or efficiency. Table 1 - describes each category.

   b. This technical workpaper only considers high-efficiency unit heaters (>90% TE) as direct alternatives for conventional unit heaters. Direct-fired heaters introduce outside air to the space while providing space heating, and require separate sizing and energy savings analysis as the equipment offsets a portion of infiltration and ventilation loads. Infrared heaters employ a different heat transfer mechanism that only heats objects, not air, and require additional consideration for the space being heated. Additionally, infrared heaters currently do not have a standardized

efficiency metric, such as AFUE or steady-state thermal efficiency that allows consumers to easily compare between products or applications. The infrared-heating industry is currently working on a unified heating efficiency metric through AHRI Standard 1330P, *Radiant Output Rating Standard for Gas-Fired Infrared Heaters*, and is expected for public publication in late 2014.

Table 1 - Classification of Non-Centralized Gas Fired Space Heating Equipment

Category	Combustion/ Exhaust Type	Heat Transfer Type	Exhaust Type	Description
Unit Heater	**Indirect:** Combustion products *do not* enter building	**Fan Convection**	**Flue through wall or ceiling**	• Natural gas is combusted into a heat exchanger before exiting through a flue • Fan circulates air across the heat exchanger, warming the space
Direct-Fired Heater	**Direct:** Combustion products *do* enter building[4]	**Fan Convection**	**Directly into heating space**	• Fan propels products of natural gas combustion into the space • Uses either indoor or outdoor air to heat the space
Infrared Heater	**Indirect:** Combustion products *do not* enter building	**Thermal Radiation**	**Flue through wall or ceiling**	• Natural gas is combusted and exhaust gases are piped through the space before exiting a flue • High-temperature exhaust gases generate thermal radiation which is reflected to the objects within the space by mirrors

B. Pre-existing Description
   1. As stated in Section 1.03 Code Analysis (below), the baseline efficiency of this measure is 80% thermal efficiency.

C. Measure Efficiency
   1. Minimum of 90% thermal efficiency needs be met as a qualifying efficiency for this unit heater measure.

D. Measure Descriptors

Table 2 - Measure Descriptors [5,6]

MeasureID	Use-Category	UseSub-Category	Tech Group	Tech Type	PreTech Group	PreTech Type	StdTech Group	StdTech Type
	HVAC	Space-Heat	Space-Htg_eq	Gas Furnace	Space-Htg_eq	Gas Furnace	Space-Htg_eq	Gas Furnace

E. Delivery Type
   1. This measure is applied as a prescriptive rebate.

Table 3 - Delivery Types

Delivery Type	Description
PreReb	***Prescriptive Rebate***

F. Measure Application Type

Table 4 - Measure Application Type

Code	Description	Comment
NC	*New Construction*	*measure applied during construction design phase as an alternative to a code-compliant standard design*
ROB	*Replace on Burnout*	*measure applied when existing equipment fails or maintenance requires replacement*

G. Eligibility Requirements
1. Unit heaters must operate within an enclosed space and connect to a control or thermostat at an accessible location.
2. The purchased unit must have thermal efficiency of 90% or above.
3. Participants in the program must be in good standing with the administering IOU.

H. Implementation Requirements
1. Measure applies to non-residential gas customers only.

Table 5 - Sector and Subsector(Building Type)

Measure ID	Sector	Subsector	Subsector(Building Type) Description
	Ag	***APF***	***Agricultural Produce Farms***
	Com	***Any***	***Commercial (Weighted Average)***
	Ind	***Any***	***Industrial - All Subsectors***

I. Terms and Conditions
1. A copy of invoice must be provided as a proof of the unit purchased.
2. Make and model number must be included with a copy of customer's receipt.

1.02 DEER DIFFERENCES ANALYSIS

A. The Database for Energy Efficient Resources (DEER) does not have any measures that match the high efficiency commercial gas-fired unit heater measure.

Table 6 - DEER Difference Summary

Modified DEER Methodology	**No**
Scaled DEER Measure	No
DEER Building Prototypes Used	No
Deviation from DEER	N/A
DEER Version	N/A
DEER Run ID and Measure Name	N/A

1.03 CODE ANALYSIS

A. Code/Standard Description
   1. California state and federal efficiency standards require gas-fired unit heaters manufactured on or after August 8, 2008 to:
      a. Be equipped with an intermittent ignition device; and
      b. Have power venting or an automatic flue damper.

   2. California Title 24-2013 (July 1, 2014) requires gas-fired, warm-air unit heaters to have a minimum combustion efficiency of 80% when tested to ANSI Z83.8.

Table 7 - Code Summary

Code	Applicable Code Reference	Effective Dates
Title 24 (2013)	Table 110-2-J, Warm-Air Furnaces and Combination Warm-Air Furnaces / Air-Conditioning Units, Warm-Air Duct Furnaces, and Unit Heaters	July 1, 2014
Title 20 (2014)	Section 1605.1(e)	July 1, 2014
Federal Code	Federal Register Part 431, Subpart N [71 FR 71374]	August 8, 2008

1.04 MEASURE EFFECTIVE USEFUL LIFE

A. This workpaper adopts the estimate of a 20 year average life for gas-fired unit heaters based as suggested by the California Technical Forum and DEER EUL for commercial gas-fired furnace (EUL_ID HVAC-Frnc).

   1. There was no specific Effective Useful Life (EUL) found in the DEER database for commercial gas-fired unit heaters. However, DEER lists the EUL for commercial gas-fired furnace as 20 years.
   2. DEG (see Section 1.08 B below) adopts 15 years. ACEEE 2003 study estimates 15~25 years. DOE's shipping data uses 21.5 years (17~26 years).

Table 8 - Effective Useful Life

MeasureID	EUL ID	EUL Yrs	RUL Yrs	Description
	HVAC-Frnc	20	6.7	Commercial High Efficiency Furnace

1.05 NET-TO-GROSS RATIOS FOR DIFFERENT PROGRAM STRATEGIES

Table 9 - Net-to Gross Ratio

MeasureID	NTGR ID	NTGR_therm	Description	Delivery Type
	All-Default<=2yrs	0.70	All other EEM with no evaluated NTGR: new technology in program for 2 or fewer years	Any

A. This measure assumes a NTGR of 0.70 for the high efficiency commercial gas-fired unit heaters energy efficiency measure. All-Default<=2yrs[7].

1.06 TIME-OF-USE ADJUSTMENT FACTOR

A. TOU adjustment factor is 0 as this is a gas heating measure, not commercial/residential A/C measure.

1.07 GROSS SAVINGS AND INSTALLATION ADJUSTMENT (GSIA)

A. This measure assumes the default GSIA value of 1.

Table 10 - GSIA Table

MeasureID	GSIA ID	GSIA Type	GSIA Value	Description
	Def-GSIA	Annual Installation Rate	1	Default GSIA Value

1.08 EM&V, MARKET POTENTIAL, AND OTHER STUDIES – BASE CASE AND MEASURE CASE INFORMATION

A. In 2003, ACEEE conducted an analysis to draw attention to the potential energy savings of gas-fired unit heaters for commercial buildings[8]. The analysis examined the energy savings associated with replacing a conventional gas-fired unit heater with different unit heater technologies, including condensing heat exchangers. The analysis determined that a condensing unit heater (90% thermal efficiency) would save 660 Th/year over a power-vented unit heater (80% thermal efficiency) assuming 220,000 Btu/hr capacity, no oversizing, and 2,000 heating load hours. The study does not provide an exact calculation of their estimate.

B. In 2004, Davis Energy Group (DEG) conducted an analysis on the potential energy savings of gas-fired unit heaters for the PG&E Codes and Standards Enhancement (CASE) Initiative Project[9]. The analysis was conducted similar to the ACEEE study, but focused more on California. The analysis determined that a condensing unit heater (90% thermal efficiency) would save 96 Th/year over a power-vented unit heater (80% thermal efficiency) assuming 220,000 Btu/hr capacity, 100% oversizing, and 1,000 heating load hours. The study does not provide an exact calculation of their estimate.

C. Although the primary goal of these two studies was to encourage the adoption of the efficiency standards outlined in Section 1.3, their vastly different energy savings estimates for the same technology comparison demonstrates the limited information available for non-centralized space heating equipment. Typical applications of this equipment category include semi-conditioned spaces such as warehouse, garages, loading docks, and other locations regularly open to outdoor conditions. This encourages irregular design practices for gas-fired unit heaters even with the same number of heating degree days, leading to highly variable equipment heating capacity, number of units to a space, and annual operating hours. Section 2 of this document will describe the method to calculate the savings estimates.

SECTION 2 - ENERGY SAVINGS & DEMAND REDUCTION CALCULATIONS

2.01 LOAD SHAPES

A. This is a gas measure, and no load shape is considered for the savings calculation.

2.02 AVERAGE HEATING CAPACITY FOR GAS UNIT HEATERS

A. DOE published the annual shipping data for gas-fired unit heaters for common heating capacities between 1991and 1995, referencing GRI information for the U.S[10]. Table 11 - shows the number of shipments cited in the DOE study, given as a midpoint of a common range of sizes. The "Heating Capacity Estimate" worksheet details all underlying data and calculations (Attachment C - Heating Capacity Estimate). This workpaper assumes that these calculated heating capacities are applicable to SCG territory.

Table 11 - Heating Capacity for Gas-Fired Unit Heaters

Total Gas-Fired Unit Heater Shipments by Capacity 1991-1995		
Midpoint Capacity for Common Range of Sizes (kBtu/hr)	Total Number of Shipments (1,000s)	Percentage of Shipments
49.95	18,200	3.0%
99.95	60,350	10.0%
162.45	133,600	22.2%
224.95	150,650	25.0%
312.45	191,850	31.8%
437.50	48,300	8.0%
Weighted Average Capacity (kBtu/hr)	238	

$$\text{Weighted Average Capcity} = \sum \text{Capacity Range x \% of Shipments}$$

Equation 1. Weighted Average Unit Heater Capacity

2.03 HEATING LOAD HOURS

A. Determining average heating load hours for non-centralized space heating equipment are rule-of-thumb approximations and are generally accepted as such in industry analysis. The actual number of hours a unit heater will operate depends on the following:
   1. Heating degree days of the building's climate
   2. Temperature setpoint of the building
   3. Heater placement in relation to external openings such as loading docks or garage doors.

B. Despite industry best practices, heater placement within the building is often the largest determining factor affecting energy consumption, with heaters placed closer to external walls or openings having significantly higher natural gas use than internally placed units.

C. Both the ACEEE and DEG studies assumed an average number of heater operating hours based on a 1994 ARI map for the heating load hours of the U.S., shown in Figure 1. Manufacture literature (Attachment F -Modine PTC Spec Sheet, Figure 2.1) refers to a similar map when estimating potential savings of high efficiency gas-fired unit heaters. Looking at the contour map, unit heaters would be expected to operate from approximately 1,500 to 3,000 hours across the SCG territory.

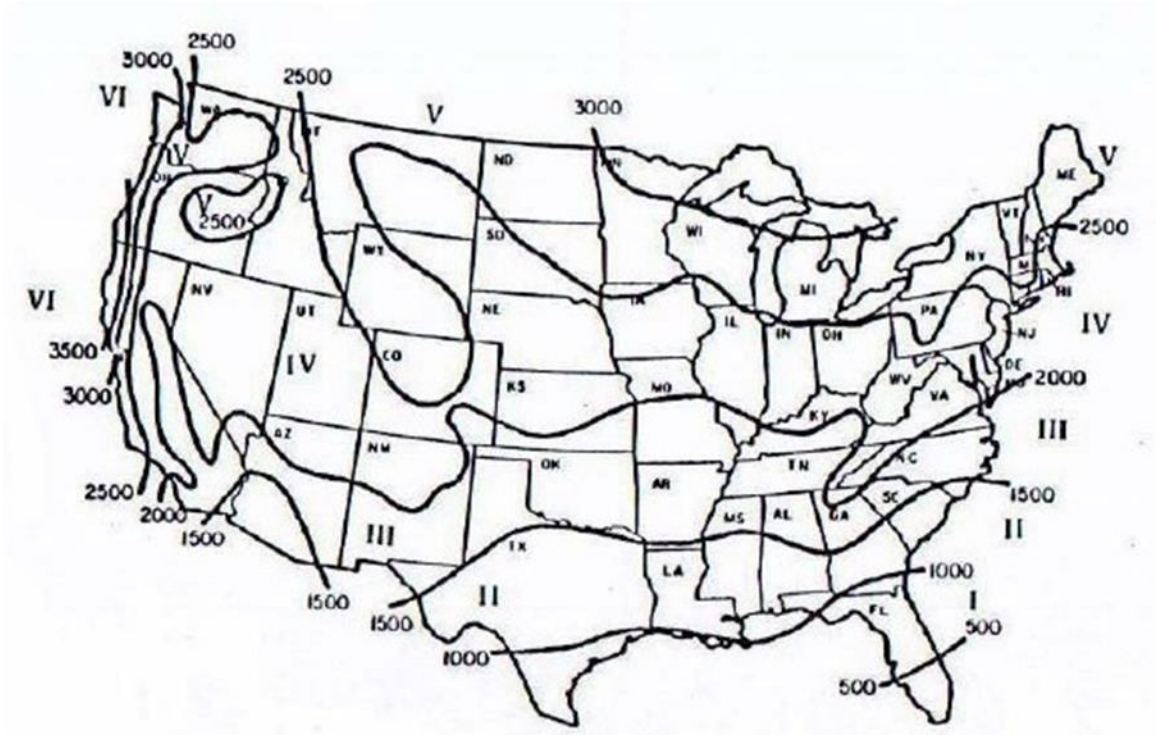

Figure 1 - Heating Load Hours in the United States

D. A better approximation would be to look at normalized natural gas consumption for warehouses from the 2006 California Commercial End-Use Survey (CEUS)[11] and adjust for California. This workpaper assumes average heating load hours for warehouses is representative of the types of spaces using non-centralized gas-fired space heating equipment for any commercial building type. The "Heating Load Hours" worksheet details all underlying data and calculations (Attachment D -Heating Load Hours).

1. Annual heating load hours for warehouse buildings can be derived from CEUS data[2] for annual natural gas heating energy use, segment floor area, and connected heating equipment load for heated warehouses in Equation 2. This provides 344 average heating load hours for the statewide average warehouse.

$$Full\ Load\ Heating\ Hours = \frac{Annual\ Energy\ Usage\ (Btu)}{Connected\ Heating\ Load\ \left(\frac{Btu}{hr-ft^2}\right) \times Total\ Segment\ Floor\ Area\ (ft^2)}$$

Equation 2. Annual Unit Heater Operating Hours

a. The effective full load hour was initially proposed to use "Non-Coincident Peak Load" from CEUS, instead of "Connected Load". However, the review comment from the Commission Staff (Attachment G -) on the calculation methodology suggested using the connected load which is 2.7 times greater than the non-coincident peak load. The comment was adopted in this calculation to result in reduction of full load heating hour estimate by that factor.

2. Using a weighted average of CEUS warehouse survey sites by CZ[12] and DEER Savings values by CZ for a similar measure (D03-065-AFUE90), the statewide average heating load hours correspond to an average of 2.36 Th/kSF using Equation 3.

$$Weighted\ Average\ DEER\ Savings = \frac{\sum DEER\ Savings\ by\ CZ\ x\ Number\ of\ Surveys\ by\ CZ}{Number\ of\ Surveys}$$

Equation 3. Weighted Average Heating Degree Days

3. The average heating load hours for each CZ can be derived through the ratio of average DEER Savings for each CZ to average statewide data through Equation 4. Table 12 -provides an operating hours breakdown for each CZ.

$$Average\ Statewide\ Operating\ Hours\ \left(\frac{Hr}{Yr}\right) \times \frac{DEER\ Savings\ by\ CZ}{Average\ Statewide\ DEER\ Savings} = CZ\ Operating\ Hours\ \left(\frac{Hr}{Yr}\right)$$

Equation 4. Unit Heater Operating Hours by Climate Zone

Table 12 - Heater Operating Hours for CEUS Statewide Average and Title 24 Climate Zones

California Climate Zone	DEER Savings (D03-065-AFUE90)	DEER Savings Ratio	Heater Operating Hours
CEUS Statewide Warehouse Average	2.36	-	**344**
1	6.32	2.68	921
2	4.19	1.77	611
3	3.43	1.45	500
4	3.33	1.41	485
5	2.46	1.04	358
6	1.68	0.71	245
7	1.21	0.51	176
8	1.47	0.62	214
9	0.95	0.40	138
10	1.26	0.53	184
11	5.01	2.12	730
12	4.63	1.96	675
13	3.59	1.52	523
14	4.52	1.91	659

15	0.58	0.25	85
16	11.15	4.72	1625

4. Average operating hours for a utility region can be determined through a weighted average of the representative operating hours for each California Title 24 climate zone and the percentage of warehouse utility customers[13] in that climate zone through Equation 5.

$$SCG\ Average\ Operating\ Hours = \sum Operating\ Hours\ by\ Climate\ Zone\ x\ \%\ of\ Utility\ Customers\ \ in\ Climate\ Zone$$

Equation 5. Weighted Average Unit Heater Operating Hours for SCG Territory

Table 13 - below provides the percentage of utility customers by climate zone, and their weighted average heater operating hours.

Table 13 - Weighted Average of Heater Operating Hours for SCG Territory

California Climate Zone	DEER Savings (D03-065-AFUE90)	Heater Operating Hours	Percentage of SCG Warehouse Customers
1	6.32	921	0%
2	4.19	611	0%
3	3.43	500	0%
4	3.33	485	1%
5	2.46	358	3%
6	1.68	245	19%
7	1.21	176	0%
8	1.47	214	28%
9	0.95	138	26%
10	1.26	184	10%
11	5.01	730	0%
12	4.63	675	0%
13	3.59	523	5%
14	4.52	659	2%
15	0.58	85	4%
16	11.15	1625	2%
SCG Weighted Average DEER Savings (D03-065-AFUE90)	1.78	SCG Weighted Average Operating Hours	**259**

2.04 ENERGY SAVINGS

A. Average performance of both conventional and high efficiency commercial gas-fired unit heaters for this analysis will be determined through the following equations:

$$Baseline\ Gas\ Consumption\ \left(\frac{kBtu}{Yr}\right) = Average\ Heater\ Capacity\ (\frac{kBtu}{Hr}) \times Annual\ Operating\ Hours\ (\frac{Hr}{Yr})$$

Equation 6. Baseline Gas-Fired Unit Heater Consumption

$$Average\ Heating\ Load\ \left(\frac{kBtu}{Yr}\right) = Baseline\ Gas\ Consumption\ \left(\frac{kBtu}{Yr}\right) \times Baseline\ Efficiency(\%)$$

Equation 7. Average Heating Load

$$High\ Efficiency\ Gas\ Consumption\left(\frac{kBtu}{Yr}\right) = \frac{Average\ Heating\ Load\ \left(\frac{kBtu}{Yr}\right)}{High\ Efficiency(\%)}$$

Equation 8. High Efficiency Gas-Fired Unit Heater Consumption

B. The average heating capacity for gas-fired unit heaters and average heating load hours outlined in Section 2.1 were used to estimate the average annual natural gas consumption for both conventional and high efficiency unit heaters. As Table 14 - shows, high efficiency gas-fired space heating equipment reduces natural gas consumption by 11.1% or 69 Th/yr for average across SCG, and 91 Th/yr for CA statewide average. This value compares closely to the DEG study (96 Th/yr)[14]. On a capacity basis, gas savings are 0.29Th/kBtu-hr and cost savings are $0.19/kBtu-hr. The “Impact Estimate” spreadsheet details all underlying data and calculations.

Table 14 - Average Annual Natural Gas Consumption and Savings for Title 24 Climate Zones and SCG Territory

California Climate Zone	Per Unit Estimate (238 kBtu/hr)		Per Capacity Estimate (kBtu/hr)	
	Baseline Consumption (Therms/Unit)	Natural Gas Savings (Therms/ Unit)	Baseline Consump-tion (Therms/ kBtu-hr)	Natural Gas Savings (Therms/ kBtu-hr)
1	2192	244	9.21	**1.02**
2	1453	161	6.11	**0.68**
3	1190	132	5.00	**0.56**
4	1155	128	4.85	**0.54**
5	853	95	3.58	**0.40**
6	583	65	2.45	**0.27**
7	420	47	1.76	**0.20**
8	510	57	2.14	**0.24**
9	329	37	1.38	**0.15**
10	437	49	1.84	**0.20**

11	1738	193	7.30	**0.81**
12	1606	178	6.75	**0.75**
13	1245	138	5.23	**0.58**
14	1568	174	6.59	**0.73**
15	201	22	0.85	**0.09**
16	3867	430	16.25	**1.81**
SCG Weighted Average	617	69	2.59	**0.29**
Statewide California Average	819	91	3.44	**0.38**

SECTION 3 - BASE CASE & MEASURE COSTS

3.01 BASE CASE COST

A. To estimate the incremental cost of an advanced gas-fired unit heater, this study uses pricing data from eComfort.com. Table 15 - shows the average incremental cost for unit heaters weighted by shipments of available capacities.

B. This data represents an average unit heater manufactured in the U.S., Modine and Reznor. Attachment E - - "Incremental Cost Estimate" documents the details of this analysis.

C. The base cost is $7.17 per kBtuh input rate. No labor cost is included in this figure.

Table 15 - Unit Heater Cost Analysis

Technology Type	Cost/kBtu-hr
Standard	$7.17
High Efficiency	$17.21
Incremental Cost (Unit Heater only)	$10.04

3.02 GROSS MEASURE COST

A. As discussed in the Section 3.1, above, the measure equipment cost is approximately $17.21/kBtu-hr. Per manufacturers, installation costs will vary based on the application, as site-specific conditions will dictate whether installation is higher or lower than conventional unit heaters. Condensing heaters require condensate disposal and a dedicated flue vent, but also utilize less expensive PVC for the exhaust flue. From conversations with condensing

unit heater equipment manufacturers, separate estimates for installation cost can be applied for New Construction or Replace on Burnout applications:

B. Manufacturers estimated $500 additional cost for a representative unit (238 kBtuh) since condensing unit heaters is required for replacement of existing flue and potential repositioning. On a per capacity basis, this results in $2.10/kBtu-hr additional labor and material for the gross measure cost.

C. The total measure cost of $19.31/kBtu-hr, including the additional labor and material for the installation of a condensing unit heater.

3.03 INCREMENTAL MEASURE COST

A. For New Construction (NEW) program type, the total incremental measure cost of $10.04/kBtu-hr is used.

B. For Replace on Burnout (ROB) program type, the total incremental measure cost of $12.14/kBtuh- ($19.31 - $7.17) is used.

Table 16 - IMC

Metric	Value	Source/Assumptions
Base Cost	$7.17	
Measure Cost	$17.21	Assumes cost to replace existing flue.
Additional Installation Cost	$2.10	Assume representative capacity of 238 kBtu/hr
Gross Incremental Measure Cost	$12.14	

Attachments

Attachment A - Measure Template

Measure_Template.xlsx

Attachment B - Measure Template Support Tables

Measure_Template_Support_Tables.xlsx

Attachment C - Heating Capacity Estimate

Heating Capacity Estimate.xlsx

Attachment D - Heating Load Hours and Savings Estimate

Heating Load Hours and Savings Estimate

Attachment E - Incremental Cost Estimate

Incremental Cost Estimate.xlsx

Attachment F - Modine PTC Spec Sheet

Modine PTC Spec Sheet.pdf

Attachment G - Workpaper Abstract Review Comments, CPUC, Energy Division

CalTFWorkpaperInputUnitHeatersSeptember2014-v2clean.docx

Appendix

A1. Changes made through Cal TF review process

A. EFLH (Effective Full Load Hours)

a. When this measure was first introduced to the Cal TF in June 2014, the proposed savings calculation methodologies considered following two approaches.

i. Use of eQuest modeling to model a warehouse building

ii. Engineering calculation using the baseline consumption provided in 2009 CEUS study for warehouses.

b. The second approach was recommended by the Cal TF, and the workpaper employed the recommended methodology in this workpaper.

c. The Commission Staff also reviewed the proposed savings calculation and provided the comments to revise the calculation (Attachment G -). Also see Section 2.03.D.1a for the revised savings calculation.

B. Oversizing Factor

a. It is a common practice to oversize the equipment when installing a new unit to provide enough heating capacity for a given building space. However, for the savings estimate purpose, the Cal TF agreed to disregard the oversizing factor. The use of "Connected Load" from CEUS for warehouses automatically accounts for the oversizing (over 270%) of the heating equipment.

C. Enclosed space & temperature control requirements

a. The requirement for the measure was added in Section 1.03.G as suggested by the Cal TF.

D. Cost

a. The manufacturers were consulted to identify the additional labor/material associated with the installation of condensing units. See Section 3.02.B.

E. Market Potential

a. A suggestion was made to contact an engineer who was involved with CEUS study. Additional information obtained from this contact shows that about 10% of heating equipment in warehouse building type is identified as unit heater/ventilator type. This finding was not discussed in this workpaper.

Reference

[1] Itron, Inc. *California Commercial End-Use Survey Results.* March 2006. Workbook for Limited Statewide, data for All Commercial, Gas. http://capabilities.itron.com/ceusweb/

[2] Itron, Inc. *California Commercial End-Use Survey Results.* March 2006. Workbook for Limited Statewide, data for All Warehouse, Gas. http://capabilities.itron.com/ceusweb/

[3] U.S. Department of Energy. *DOE Unit Heater Spreadsheet.* November 2001. http://www1.eere.energy.gov/buildings/appliance_standards/commercial/docs/doe_heaters.xls

[4] All direct-fired heaters must comply with ANSI Z-83.4 Non-recirculating Direct Gas-Fired Industrial Air Heaters and related standards that limit the output of carbon monoxide and other combustion byproducts to safe levels and specifies gas-ignition, combustion-air, and flame control measures to safeguard against improper operation.

[5] (READI, 2014), ftp://deeresources.com/DEER/READI_v2.0.1.zip

[6] (Ex Ante Data Specification, 2014), http://eestats.cpuc.ca.gov/EEGA2010Files/GuidanceDocuments/ex_ante_specification_20140401.accdb

[7] (DEER2011 Update Net-To-Gross table, 2012), http://deeresources.com/files/DEER2011/download/DEER2011_NTGR_2012-05-16.xls

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[14] Because CEUS data consists of field measurements of actual installations, estimates based on CEUS data contain embedded equipment oversizing assumptions for the region, i.e., the measured consumption reflects prevalent equipment sizing practices.