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FOOD SERVICE

REFRIGERATED CHEF BASE

SWFS016-01

CONTENTS

MEASURE NAME

Refrigerated Chef Base

MEASURE ID

SWFS016-01

TECHNOLOGY SUMMARY

Refrigerated chef bases are found in almost all commercial kitchens. A refrigerated chef base is used to keep ingredients or prepared meals close to the cooking station, making food preparation more efficient. The capacity or size of a chef base is represented by its exterior length (feet), ranging from approximately three feet to about ten feet. The refrigerated compartment can be equipped with drawers or doors according to customer specifications. A typical chef base operates using a conventional vapor compression refrigeration cycle charged with R-404a or R-290 propane.

Cooking equipment, like griddles and char broilers, are kept on top of a commercial chef base. Pacific Gas and Electric Company (PG&E) in conjunction with the Food Service Technology Center (FSTC) conducted a study on chef bases at the FSTC laboratory facilities.[1] The goal of this study was to determine if a hot cooking load placed on top of a chef base affects the energy consumption, compressor run time, and holding capacity. The results suggest that there is little to no significant impact of this practice on the energy performance of a chef base.

MEASURE CASE DESCRIPTION

The measure case is defined as a refrigerated chef base that uses energy less than or equal to the maximum daily energy consumption (MDEC), specified below. The measure case specification was determined from data collected and analyzed for an Emerging Technology Program study conducted by Southern California Edison (SCE) ("SCE ET Study").[2] SCE conducted lab testing to determine the energy use and demand intensity of six chef base models. Because there are no applicable state or federal codes and no industry standard practice documentation, the baseline energy use intensity is assumed to equal the average of the two highest energy use intensities of units tested in the and the measure case energy usage is assumed to equal the average of the two lowest energy use intensities in the SCE ET Study sample.

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[1] Livchak, D., A. Hookfin, and M. Fink (Food Service Technology Center, FSTC). 2015. *Turbocoil RB-72-60 (R290) Electric Refrigerated Chef Base Test Report.* FSTC Report #5 01311380-R1. Prepared for Pacific Gas & Electric Company (PG&E).

Livchak, D., A. Hookfin, and M. Fink (Food Service Technology Center, FSTC). 2015. *Turbocoil RB-72-60 (R404) Electric Refrigerated Chef Base Test Report.* FSTC Report#501311381-R1. Prepared for Pacific Gas & Electric Company (PG&E).

[2] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

Southern California Edison (SCE). 2019. "SWFS016-01 - Lab Test Data Detail.zip."

Measure Case Specification

Statewide Measure ID	Measure Offering Description
SWFS016A	Exterior Length between 35 – 54 inches and MDEC <=1.5 kWh/day
SWFS016B	Exterior Length between 55 – 73 inches and MDEC <=2.4 kWh/day
SWFS016C	Exterior Length between 74 – 89 inches and MDEC <=2.9 kWh/day
SWFS016D	Exterior Length between 90 – 120 inches and MDEC <=3.9 kWh/day

BASE CASE DESCRIPTION

The base case is defined as a refrigerated chef base that which uses more energy than the measure case MDEC specified for the equivalent exterior length. See Measure Case Description.

The base case specification was determined from data collected and analyzed for an Emerging Technology Program study conducted by Southern California Edison (SCE) ("SCE ET Study").[3] SCE conducted lab testing to determine the energy use and demand intensity of six chef base models. Because there are no applicable state or federal codes and no industry standard practice documentation, the baseline energy use intensity is assumed to equal the average of the two highest energy use intensities of units tested in the and the measure case energy usage is assumed to equal the average of the two lowest energy use intensities in the SCE ET Study sample.

CODE REQUIREMENTS

Applicable state and federal standards are specified below.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2018)	None.	n/a
CA 2019 Building Energy Efficiency Standards – Title 24 (2019)	None.	n/a
Federal Standards – Code of Federal Regulations (2014)	Department of Energy, 10 CFR Parts 429 and 431None	January 1, 2017

[3] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

Southern California Edison (SCE). 2019. "SWFS016-01 - Lab Test Data Detail.zip."

A U.S. Department of Energy (DOE) Final Ruling to update the energy conservation standards for commercial refrigeration equipment in the Code of Federal Regulations (CFR)[4] defines a chef base or griddle stand as:

> *"commercial refrigeration equipment that is designed and marketed for the express purpose of having a griddle or other cooking appliance placed on top of it that is capable of reaching temperatures hot enough to cook food."*
>
> *"To clearly differentiate ''chef bases'' and ''griddle stands'' from conventional types of commercial refrigeration equipment that are currently covered by energy conservation standards, DOE proposed to establish a definition for ''chef base'' and/or ''griddle stand'' based on the unique operation of chef bases and griddle stands, which are designed to provide food-safe temperatures in extremely warm environments in excess of 200 °F, and thus are designed with uniquely robust refrigeration systems."*

The April 2014 Final Ruling clarifies that chef bases were not considered in the March 14 Final Ruling to update the CFR[5] and hence the federal energy conservation code for commercial refrigeration does not apply. This document further states that

> *"Chef bases and griddle stands are also designed to provide food-safe temperatures in extremely hot environments, and thus are designed with uniquely robust refrigeration systems. These refrigeration systems require larger compressors to provide more cooling capacity for the storage volume than equipment with compressors that are appropriately sized for more typical ambient temperatures. As a result, this equipment consumes more energy than similarly sized, standard Commercial Refrigeration Equipment (CRE) models."*

Further, the ENERGY STAR® Program Requirements Product Specification for Commercial Refrigerators and Freezers Eligibility Criteria Version 4.0[6] excludes chef bases, in-line with DOE April 2014 Final Ruling..

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

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[4] U.S. Department of Energy (DOE), Energy Conservation Program. 2014. *Energy Conservation Program Test Procedure for Commercial Refrigeration Equipment; Final Rule.* Federal Register Vol. 79, No. 76. April 21.

[5] U.S. Department of Energy (DOE), Energy Conservation Program. 2014. *Energy Conservation Program: Energy Conservation Standards for Commercial Refrigeration Equipment; Final Rule.* Federal Register Vol. 79, No. 60. March 28.

[6] ENERGY STAR. (n.d.) "ENERGY STAR® Program Requirements Commercial Refrigerators and Freezers, Eligibility Criteria Version 4.0." Effective on March 27, 2017.

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
Normal replacement (NR)	DnDeemDI	Com
Normal replacement (NR)	DnDeemed	Com
Normal replacement (NR)	UpDeemed	Com
New construction (NC)	DnDeemDI	Com
New construction (NC)	DnDeemed	Com
New construction (NC)	UpDeemed	Com

Eligible Products

The installed chef base must comply with the maximum MDEC value corresponding to the correct size, as specified in the Measure Description section

Program implementation shall collect measure data for use in updating future versions of this workpaper. The program data collected should include the following:

- Manufacturer, model number, and serial number of installed equipment
- Measure equipment costs and, if available, installation costs
- Pre-existing equipment information, if replacing existing equipment (for downstream delivery channel only)
- Customer surveys and distributor survey (if midstream delivery channel is utilized)

Eligible Building Types and Vintages

This measure is applicable for nonresidential buildings of any vintage.

Eligible Climate Zones

This measure is applicable in any California climate zone.

PROGRAM EXCLUSIONS

None.

DATA COLLECTION REQUIREMENTS

Results of an Emerging Technology Program study conducted by Southern California Edison ("SCE ET Study")[7] and market research reveal that there are two manufacturers of chef bases that are more efficient than the baseline established for this measure. After the market for efficient chef bases expands, additional data of installed chef bases will support additional efficiency tiers over the baseline and will support the increase of accuracy in the savings and costs estimates.

USE CATEGORY

Food Service

ELECTRIC SAVINGS (KWH)

The unit energy savings (UES) of this measure were derived from the results from an Emerging Technology Program study conducted by Southern California Edison ("SCE ET Study").[8] The study conducted lab testing in accordance to ASHRAE 72 Method of Testing Open and Closed Refrigeration and Freezers standards on six chef base models by different manufacturers: three with refrigerant R-404a and three with R-134a. The chef bases were monitored for two days each at 20-second time intervals; the energy use intensity (kWh/day/ft^3) was determined to vary between 0.11 and 0.60.

The annual UES is calculated as the product of the energy use intensity (kWh/day-ft^3), the refrigerated volume, and the days of operation per year, as explained below.

Baseline and Measure Case Energy Use Intensity. Considering that there are no state or federal codes, no industry standard practice documentation, the baseline energy intensity is assumed to equal the average of the two highest energy use intensities of units tested in the SCE ET Study and the measure energy usage is assumed to equal the average of the two lowest energy use intensities in the SCE ET Study sample. The calculated baseline and measure energy and demand intensities from the SCE ET Study are shown below.

Energy and Demand Intensities

	Energy Use Intensity (kWh/day-ft^3)	Peak Demand Intensity (kW/ft^3)
Baseline	0.54	0.023
Measure case	0.16	0.008

[7] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

[8] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

Southern California Edison (SCE). 2019. "SWFS016-01 - Lab Test Data Detail.zip."

The refrigerated chef bases in the SCE ET Study were categorized based on the outside length ranging from 36" to 120". Typically, there are four size categories as below in the market.

Chef Base Size Categories

Size Category	Exterior length (inches)
1	35 – 54
2	55 – 73
3	74 – 89
4	90 – 120

Five of the six chef bases in SCE ET study are size category 2. Even though the energy use intensities are normalized to volume, linearly extrapolating the energy intensity values from the SCE ET Study to other sizes was not appropriate since there could be some baseloads irrespective of the size category.

Published energy usage values for chef base models were obtained from manufacturer published data, representing all four size categories. This data was used to calculate the relative variation of energy use intensities based on the size. The percentages below were applied to the baseline and measure case energy and demand intensities to determine the energy and peak demand intensities for size categories 1, 3, and 4.

Variation of Energy Intensity Relative to Size

Size Category	Energy Use Intensities Relative to Size Category 2
1	12%
2	0%
3	-12%
4	-13%

Refrigerated Volume. The refrigerated volume of each size category was needed to convert the energy and demand intensities to unit energy consumption (UEC) values. The height and depth are constant for a range of products from each manufacturer; among different manufacturers there is a minimal variation in the height and depth. Of the six chef bases tested (from different manufacturers) in the SCE ET Study, the coefficient of variation of refrigerated height and depth were 9.31% and 7.24%, respectively. Hence, this analysis considered length as the primary independent parameter and categorized the chef bases into four sizes similar to the products in the market. The average refrigerated 'height x depth' was calculated for the six chef bases, which was used to calculate the volume of each chef base.

Each model had a similar difference between the outside length and the inside refrigerated length (L). Using the constant difference and outside length, the average refrigerated inside length (L) was calculated for each size category. The average refrigerated volume for each size category was then calculated using the average refrigerated inside length and average refrigerated 'height x depth' summarized above.

Days of Operation per Year. Refrigerated chef bases are assumed to operate 365 days per year with no noticeable variation in operation.

Unit Energy Savings. The UES was calculated as the product of the energy use intensity (kWh/day-ft^3), the refrigerated volume, and the days of operation per year, as shown below. [9]

$$UES_{kWh} = UEI\_Day \times REFVOL \times DAY$$

UES = *Annual unit energy savings (kWh/yr)*
EUI_Day = *Energy use intensity (kWh/day-ft³)*
REFVOL = *Refrigerated volume (ft³)*
DAYS = *Operating days per year (days/yr)*

UES Inputs

Parameter	Value	Source
Energy use intensity (kWh/day-ft^3)	Varies by size	Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.
Refrigerated volume (ft^3)	Varies by size	Southern California Edison (SCE). 2019. "SWFS016-01 – Savings and Cost Analysis.xlsx."
Operating days per year	365	Professional judgement.

PEAK ELECTRIC DEMAND REDUCTION (KW)

The unit peak demand reduction of this measure was derived from the results from an Emerging Technology Program study conducted by Southern California Edison ("SCE ET Study").[10] The demand intensity was calculated as part of the SCE ET Study is determined appropriate to calculate the peak demand reduction during the peak period of 4:00 p.m. to 9:00 p.m.[11]

Peak demand reduction was calculated as the product of the peak demand intensity and the refrigerated volume. [12]

$$PDR = PDI \times REFVOL$$

PDR_{kW} = *Peak demand reduction (kW)*
PDI = *Peak demand intensity (kW/ft³)*
REFVOL = *Refrigerated volume (ft³)*

[9] Southern California Edison (SCE). 2019. "SWFS016-01 – Savings and Cost Analysis.xlsx."

[10] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

Southern California Edison (SCE). 2019. "SWFS016-01 - Lab Test Data Detail.zip."

[11] California Public Utilities Commission (CPUC). 2018. *Resolution E-4952.* October 11. O.P. 1.

[12] Southern California Edison (SCE). 2019. "SWFS016-01 – Savings and Cost Analysis.xlsx."

See Electric Savings for the derivation of the peak demand intensity and refrigerated volume.

GAS SAVINGS (THERMS)

Not applicable.

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 EUL and RUL are presented below. The estimated lifetime adopted for this measure is the EUL associated with a commercial reach-in refrigerator. Note that RUL is only applicable for add-on equipment and accelerated replacement measures thus not applicable for this measure.

Effective Useful Life and Remaining Useful Life

Parameter	Value (years)	Source
EUL (yrs) – measure	12.0	California Public Utilities Commission (CPUC), Energy Division. 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
RUL (yrs) – measure	n/a	-

BASE CASE MATERIAL COST ($/UNIT)

Material costs were derived from manufacturer quotes or price sheets available on the internet for four of the six products tested in the Emerging Technology Program study conducted by Southern California Edison ("SCE ET Study").[13] This cost data was augmented with cost data for chef base models not in the SCE ET Study.

Each model in the sample was assigned to a size category and identified as either a base case or measure case model based upon the published daily energy usage. Note that the cost for two products from two different manufacturers were identified as outliers and not included in the final cost analysis.

The measure case material cost was calculated as the average cost of measure case models in the sample.[14]

[13] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

[14] Southern California Edison (SCE). 2019. "SWFS016-01 – Savings and Cost Analysis.xlsx." See "Cost Analysis" tab.

MEASURE CASE MATERIAL COST ($/UNIT)

Material costs were derived from manufacturer quotes or price sheets available on the internet for four of the six products tested in the Emerging Technology Program study conducted by Southern California Edison ("SCE ET Study").[15] This cost data was augmented with cost data for chef base models not in the SCE ET Study.

Each model in the sample was assigned to a size category and identified as either a base case or measure case model based upon the published daily energy usage. Note that the cost for two products from two different manufacturers were identified as outliers and not included in the final cost analysis.

The base case material cost was calculated as the average cost of base case models in the sample.[16]

BASE CASE LABOR COST ($/UNIT)

The refrigerated chef base is a simple plug-in and remove appliance and do not require significant labor. Hence, the labor cost is assumed to equal $0. It is also assumed that the labor installation will be identical for a base case and measure case unit.

MEASURE CASE LABOR COST ($/UNIT)

The refrigerated chef base is a simple plug-in and remove appliance and does not require significant installation labor. Hence, the labor cost is assumed to equal $0. It is also assumed that the labor installation will be identical for a base case and measure case unit.

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. This 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 more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

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

[15] Southern California Edison (SCE), Emerging Products. 2016. *Chef Bases for Foodservice Applications. ET15SCE1010 Report.* August.

[16] Southern California Edison (SCE). 2019. "SWFS016-01 – Savings and Cost Analysis.xlsx." See "Cost Analysis" tab.

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 Rate

Parameter	Value	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 impacts for this measure have not been quantified.

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods from 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 / Used for Measure
Modified DEER methodology	No
Scaled DEER measure	No
DEER Base Case	No
DEER Measure Case	No
DEER Building Types	Yes
DEER Operating Hours	No
DEER eQUEST Prototypes	No
DEER Version	n/a
Reason for Deviation from DEER	This measure is not in DEER.
DEER Measure IDs Used	n/a
NTG	Source: DEER2014. The NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs*
GSIA	Source: DEER. The GSIA of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER2014. The value of 12 years is associated with EUL ID: *Cook-GDRef*

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	05/31/2019	Akhilesh Endurthy Solaris-Technical	New statewide measure, based upon: SCE17CO17, Revision 0 (May 4, 2018) Updated: New Statewide workpaper template DEER2020/E-4952 updates
	06/08/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.
	08/14/2020	Jesse Manao, SCE	EAD fix on Cost Tab, switched cost value between base and measure case costs.