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FOOD SERVICE

INSULATED HOT FOOD HOLDING CABINET

SWFS007-02

CONTENTS

MEASURE NAME

Insulated Hot Food Holding Cabinet

STATEWIDE MEASURE ID

SWFS007-02

TECHNOLOGY SUMMARY

A commercial insulated hot food holding cabinet that meets program requirements incorporates better insulation for reduced heat loss and provides better temperature uniformity, as well as additional energy saving features such as magnetic door gaskets, auto-door closers, or Dutch doors. Qualified hot food holding cabinets are more effective at maintaining food temperature while using less energy.

Holding cabinet performance is determined by applying the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Hot Food Holding Cabinets (F2140).[1] The ASTM standard test method is the industry standard for quantifying the efficiency and performance of hot food holding cabinets.

MEASURE CASE DESCRIPTION

Each HFHC is classified based on its cabinet volume as either Half-Size (< 15 ft^3) or Full-Size (≥ 15 ft^3). For each size category, a Normalized Idle Energy Rate in W/ft^3 is determined by dividing the average measured Idle Energy Rate by the average measured cabinet volume. The average measure case holding cabinet specifications for full-size (≥ 15 ft^3) and half-size (< 15ft^3) insulation hot food holding cabinets are provided below. The idle energy rate for efficient cabinets was updated based on the average between the CEC and ENERGY STAR databases normalized per cabinet volume.

Measure Case Specification

Cabinet Size	Cabinet Vol. (ft^3)	Normalized Idle Energy Rate (W/ft^3)	Total Cabinet Idle Energy Rate (kW)	Source
Full-Size (≥ 15 ft^3)	25	12	0.30	Average of efficient cabinets between CEC and ENERGY STAR databases. Per recommendation of Frontier Energy study.
Half-Size (< 15 ft^3)	10	18	0.18	

[1] American Society for Testing and Materials (ASTM). 2019. *ASTM F2140-19, Standard Test Method for the Performance of Hot Food Holding Cabinets.* West Conshohocken (PA): ASTM International.

BASE CASE DESCRIPTION

The base case specification for full (≥ 15 ft^3) and half-size (< 15ft^3) insulated hot food holding cabinets is based on HFHC Test Data collected per the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Hot Food Holding Cabinets (F2140).[2] See Code Requirements.

Representative cabinet volume was left to be 10 ft^3 and 25 ft^3 for half- and full-size cabinets, respectively, with the Food Service Technology Center (FSTC) and California Energy Commission (CEC) lists showing similar average volumes. The idle energy rate for baseline cabinets was updated based on the average between the FSTC and CEC databases normalized per cabinet volume.

The following factors were used to conclude that baseline systems from the FSTC database included systems that are currently being sold in the marketplace:

- The baseline data from the FSTC database includes test dates of cabinets ranging from 2000 to 2015. Furthermore, 18 of 22 of the tests were performed within the past 11 years.
- While specific holding cabinet models were not available in the FSTC data, average normalized base case energy rates of FSTC data was found to be lower than the average normalized energy rates found in CEC databases, which does include systems that are actively sold in the marketplace.
- All systems measured are below the maximum normalized idle energy rate requirement by Title 20 (2014).

Base Case Specification

Cabinet Size	Cabinet Vol. (ft^3)	Normalized Idle Energy Rate (W/ft^3)	Total Cabinet Idle Energy Rate (kW)	Source
Full-Size (≥ 15 ft^3)	25	25	0.62	Average of FSTC/Frontier Energy HFHC Test Data per ASTM F2140 and CEC database. Per recommendation of Frontier Energy study.
Half-Size (< 15 ft^3)	10	35	0.35	

CODE REQUIREMENTS

This measure is governed by the California Appliance Efficiency Regulations (Title 20),[3] which requires all new commercial hot food holding cabinets to have a maximum normalized idle energy rate of 40 W/ft^3 of interior volume based on American Society for Testing and Materials (ASTM) Standard Test Method for

[2] American Society for Testing and Materials (ASTM). 2019. *ASTM F2140-11, Standard Test Method for the Performance of Hot Food Holding Cabinets.* West Conshohocken (PA): ASTM International.

[3] California Energy Commission (CEC). 2014. *2014 Appliance Efficiency Regulations.* CEC-400-2014-009-CMF.

the Performance of Hot Food Holding Cabinets (F2140).[4] The ASTM standard test method is the industry standard for quantifying the efficiency and performance of hot food holding cabinets.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Dates
CA Appliance Efficiency Regulations – Title 20 (2014)	Section 1605.3(r)(2)	July 1, 2014
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards	None.	n/a

NORMALIZING UNIT

Each

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

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

[4] American Society for Testing and Materials (ASTM). 2019. *ASTM F2140-11, Standard Test Method for the Performance of Hot Food Holding Cabinets.* West Conshohocken (PA): ASTM International.

Measure Application Type	Delivery Type	Sector
New construction	DnDeemDI	Ind
New construction	DnDeemDI	Com
New construction	UpDeemed	Ag
New construction	UpDeemed	Ind
New construction	UpDeemed	Com

Eligible Products

This measure includes new full-size (≥ 15 ft^3) and half-size (< 15ft^3) insulated food holding cabinets. Eligible products must meet the following requirements:

- Qualifying cabinets must not exceed the maximum idle energy rate of 25 W/ft^3 for full-size cabinets and 35 W/ ft^3 for half-size cabinets, in accordance with the American Society for Testing and Materials (ASTM) Standard Test Method for the Performance of Hot Food Holding Cabinets (F2140).[5]
- All measures must be electric hot food holding cabinets that are fully insulated (i.e., on all sides) and have solid or transparent doors designed to maintain the temperature of hot food that has been cooked using a separate appliance.
- Eligible holding cabinets must listed be on the Food Service Technology Center (FSTC) qualified product list (https://fishnick.com/saveenergy/rebates/).

Eligible Building Types and Vintages

This measure is applicable for any nonresidential building type of any vintage.

Eligible Climate Zones

This measure is applicable in any California climate zone.

PROGRAM EXCLUSIONS

This measure does not include cook-and-hold or retherm equipment. Used or rebuilt equipment are not eligible. Any cabinets considered in this measure must have an electric resistance heating element, passive holding cabinets with no heating elements are not eligible.

DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

[5] American Society for Testing and Materials (ASTM). 2019. *ASTM F2140-11, Standard Test Method for the Performance of Hot Food Holding Cabinets.* West Conshohocken (PA): ASTM International.

USE CATEGORY

FoodServ

ELECTRIC SAVINGS (kWh)

The annual unit energy saving (UES) is then calculated as the difference between the baseline and measure case unit energy consumption (UEC).

The **daily UEC** of a commercial insulated hot food holding cabinet is a function of the cabinet size, idle energy rate, and operating hours per day.[6] The annual UEC is calculated as the daily UEC multiplied by the number of operating days per year.

$$UEC\_DAY = CVOL \times IDLERATE \times EHOU$$

$$UEC\_YEAR = UEC\_DAY \times EDAYS$$

$UEC\_DAY =$	*Calculated daily energy consumption (kWh/day)*
$CVOL =$	*Cabinet size (ft^3)*
$IDLERATE =$	*Idle energy rate (kW/ft^3)*
$EHOU =$	*Estimated operating hours per day (hrs)*
$UEC\_YEAR =$	*Calculated annual energy consumption (kWh/year)*
$EDAYS =$	*Estimated operating days per year (days)*

The **annual UES** is calculated as the difference between the baseline and measure case annual UEC.

$$UES\_YEAR = [UEC\_YEAR_{Base} - UEC\_YEAR_{Measure}]$$

The inputs and assumptions for the calculation of the annual UEC of a full-size and half-size cabinet are specified below. Energy usage calculations are based on a typical temperature setting of 150°F. Note that the different sizes for the holding cabinets (half size and full size) have proportional operating energy rates.

The idle energy rate for efficient cabinets was updated based on the average between the CEC and ENERGY STAR databases normalized per cabinet volume. In the California Energy Commission's (CEC) *Electric Plug Load Savings Potential of Commercial Foodservice Equipment*[7] study set to conclude in 2020, Frontier Energy monitored both baseline and replacement (i.e. energy efficient) holding cabinets across different facility types. The average operating time for holding cabinets was 8.9 hours per day or 3,267 hours per year. Although not all holding cabinets are on seven days a week, the average operating hours include the days that they are not turned on. For example, a holding cabinet that is on 14-hours per day, 5-days per week is shown as a 10 hour a day average.

[6] American Society for Testing and Materials (ASTM). 2019. *ASTM F2140-11, Standard Test Method for the Performance of Hot Food Holding Cabinets.* West Conshohocken (PA): ASTM International.

[7] Frontier Energy, Inc. *Electric Plug Load Savings Potential of Commercial Foodservice Equipment*. (California, CEC-EPC-15-027, 2019). https://fishnick.com/cecplug/

Additional survey data were collected among 14 SoCalGas rebate participants, however it was concluded that monitoring data used to determine hours in the CEC study was more reliable than an estimated operating range indicated by the responses provided.

UEC Inputs - Full Size Insulated Hot Food Holding Cabinet

Parameter	Base Case Model	Measure Case Model	Source
Cabinet Size (ft³)	25	25	Baseline Case: Average of FSTC/Frontier Energy HFHC Test Data per ASTM F2140 and CEC database. Measure Case: Average of efficient cabinets between CEC and ENERGY STAR databases. Per recommendation of Frontier Energy study.
Idle Energy Rate by Volume (W/ft³)	25	12	
Operating Hours per Day (hr/day)	9	9	Frontier Energy, Inc. Electric Plug Load Savings Potential of Commercial Foodservice Equipment. (California, CEC-EPC-15-027, 2019).
Operating Days per Year (days)	365	365	

UEC Inputs - Half-Size Insulated Hot Food Holding Cabinet

Input	Base Case Model	Measure Case Model	Source
Cabinet Size (ft³)	10	10	Baseline Case: Average of FSTC/Frontier Energy HFHC Test Data per ASTM F2140 and CEC database. Measure Case: Average of efficient cabinets between CEC and ENERGY STAR databases. Per recommendation of Frontier Energy study.
Idle Energy Rate by Volume (W/ft³)	35	12	
Operating Hours per Day (hr/day)	9	9	Frontier Energy, Inc. Electric Plug Load Savings Potential of Commercial Foodservice Equipment. (California, CEC-EPC-15-027, 2019).
Operating Days per Year (days)	365	365	

A sample calculation of the annual UEC of a half-size base case holding cabinet is provided below.

$$UEC\_YEAR = CVOL \times ERATE \times EHOU \times EDAY$$

$$UEC_{YEAR} = 10 \times 0.035 \times 9 \times 365 = 1{,}149.75\ kWh/year$$

PEAK ELECTRIC DEMAND REDUCTION (KW)

It is assumed that this measure operates within the Database of Energy Efficient Resources (DEER) peak period of 4 p.m. to 9 p.m. on weekdays[8] at a constant load throughout the day. The estimated average and peak demand reduction is based on measured data for base case and measure case insulated holding cabinets using parameters for Electric Savings. The measured data are derived from tests conducted under ASTM Standard Test Method for the Performance of Hot Food Holding Cabinets (F2140).

The average demand (baseline or measure case) is equal to the annual unit energy consumption (UEC) divided by the assumed annual hours of operation.

$$Demand_{avg} = \frac{UEC\_YEAR_{kWh}}{EDAYS \times EHOUR}$$

UEC_YEAR = *Annual UEC, baseline or measure (kWh/year)*
EDAYS= *Estimated operating days per year (days)*
EHOUR= *Estimated operating hours per day (hrs)*

The average demand reduction, therefore, is the difference between the baseline and measure case average demand. The estimated **peak demand reduction** is calculated as the average demand reduction multiplied by the coincident demand factor (CDF).

Demand Reduction Inputs (all sizes)

Parameter	Base Case Model	Source
Coincident Demand Factor (CDF)	0.90	Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for Southern California Edison. Pages 3-15 to 3-17, Table 3-14.

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 specified for hot food holding cabinets are specified below. Note that RUL is only applicable for add-on and accelerated replacement measures and not applicable for this measure.

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

Effective Useful Life and Remaining Useful Life

Parameter	Value (all sizes)	Source
EUL (yrs)	12	Robert Mowris & Associates. 2005. *Ninth Year Retention Study of the 1995 Southern California Gas Company Commercial New Construction Program*. Prepared for Southern California Gas Company. Study ID Number 718A. California Public Utilities Commission (CPUC), Energy Division. 2003. *Energy Efficiency Policy Manual v 2.0.* Page 18 Table 4.1.
RUL (yrs)	n/a	n/a

BASE CASE MATERIAL COST ($/UNIT)

The base case material cost for equipment *delivered via direct install* is equal to $0.

For *all other delivery types*, the base case material cost was derived as the average of the manufacturer list prices for insulated hot food holding cabinet models retrieved from the AutoQuotes online catalog for food service equipment and supplies.[9] Because it is common knowledge that dealers do not pay the published list prices for equipment, it was necessary apply a discount factor to the AutoQuotes data to more accurately reflect the actual prices paid for the equipment. The discount factor of 50% was based upon professional judgement by the Southern California Edison (SCE) Food Service Technology Center (FSTC) staff. Additional analysis to validate the reasonableness of this value was conducted by comparing AutoQuotes published prices with actual prices on invoices submitted through the Southern California Gas Company Instant Rebates! point-of-sale rebate program from 2015 through August of 2017.[10] This verification revealed that a "list-to-actual" cost ratio for food service equipment of 50% is a reasonable average discount factor.

MEASURE CASE MATERIAL COST ($/UNIT)

The measure case material cost for *all delivery types* was derived as the average of the manufacturer list prices retrieved from the AutoQuotes online catalog for food service equipment and supplies.[11] Because it is common knowledge that dealers do not pay the published list prices for equipment, it was necessary apply a discount factor to the AutoQuotes data to more accurately reflect the actual prices paid for the equipment. The discount factor of 50% was based upon professional judgement by Southern California Edison (SCE) Food Service Technology Center (FSTC) staff. Additional analysis to validate the reasonableness of this value was conducted by comparing AutoQuotes published prices with actual prices on invoices submitted through Southern California Gas Company Instant Rebates! point-of-sale rebate program from 2015 through August of 2017.[12] This verification revealed that a "list-to-actual" cost ratio for food service equipment of 50% is a reasonable average discount factor.

[9] Food Service Technology Center (FSTC). 2016. "HFC cost tables 2016.xlsx."

[10] Energy Solutions. 2017. "2016 IMC Analysis - For Cal TF (Energy Solutions).xls."

[11] Food Service Technology Center (FSTC). 2016. "HFC cost tables 2016.xlsx."

[12] Energy Solutions. 2017. "2016 IMC Analysis - For Cal TF (Energy Solutions).xls."

BASE CASE LABOR COST ($/UNIT)

The base case labor cost for equipment *delivered via direct install* is equal to $0.

For *all other delivery types*, the base case and measure case model installation costs are expected to be the same for the customer and thus were not estimated for the incremental cost analysis.

MEASURE CASE LABOR COST ($/UNIT)

The measure case labor cost for equipment *delivered via direct install* will be derived as the average installation cost submitted by one or more implementation contractors. The actual installation cost can vary by contractor, the date when the work occurred, and by the volume of each specific contractor's business. Contractor costs are confidential information and are based upon contractually agreed upon pricing as established in their purchase order with the program administrator. Therefore, the program administrator program tracking systems are the only source for the labor installation cost data. The program administrator will utilize the actual program cost to evaluate the cost-effectiveness of the measure.

For *all other delivery types*, a high efficiency model does not require additional installation labor compared to a base case model. Since this measure is applicable for normal replacement and new construction installations, the base case and measure case model installation costs are expected to be the same for the customer and thus were not estimated for the incremental cost analysis.

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. These NTG values are based upon the average of all NTG ratios for all evaluated 2006 – 2008 commercial, industrial, and agriculture 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 commercial, industrial, and agriculture sector programs for more than two years and for which impact evaluation results are not available.

Net-to-Gross Ratios

Parameter	Value (all sizes)	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.

GROSS SAVINGS INSTALLATION ADJUSTMENT (GSIA)

The gross savings installation adjustment (GSIA) 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

Parameter	Value (all sizes)	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

The table below summarizes the inputs and methods that are and are not based upon the Database for Energy Efficient Resources (DEER).

- This measure analysis includes cost data more recent than cost presented in 2004-2005 DEER version 2.01 (measure ID D03-907).
- The DEER savings calculations use a linear savings estimate based on the average production kW inputs of a standard and energy-efficient holding cabinet over a 12-hour day, 365 days per year.
- The DEER data assumed a base case demand of 1.35 kW/hour and measure case demand of 0.43 kW/hour. This measure analysis uses the CEC Title 20 Appliance Efficiency Regulations to establish the base case demand.[13]
- The *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study* conducted by Itron[14] specifies 4,380 annual operating hours, based on 12 hours per day. This measure analysis assumes 15-hour daily operating hours, 365 days per year (5,475 hours per year), which is consistent with the Federal Energy Management Program purchasing specification for hot food holding cabinets.[15]

[13] California Energy Commission (CEC). 2014. 2014 Appliance Efficiency Regulations. CEC-400-2014-009-CMF. Section 1605.3(r)(2).

[14] Itron, Inc. 2005. *2004-2005 Database for Energy Efficiency Resources (DEER) Update Study - Final Report.* Prepared for Southern California Edison.

[15] U.S. Department of Energy (DOE), Federal Energy Management Program (FEMP). 2012. "Covered Product Category: Hot Food Holding Cabinets." http://www2.eere.energy.gov/femp/technologies/printable_versions/eep_hot_food.html. Updated May 2012.

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	No
DEER Operating Hours	No
DEER eQUEST Prototypes	No
DEER Version	n/a
Reason for Deviation from DEER	DEER 2014 does not contain this measure
DEER Measure IDs Used	n/a
NTG	NTG of 0.60 is associated with NTG ID: *Com-Default>2yrs*, Source: DEER 2016. *Ag-Default>2yrs*, *Ind-Default>2yrs*
GSIA	Source: DEER 2016. The GSIA value of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER 2014. EUL of 12 years is associated with EUL-ID: *Cook-HoldCab*. See 2004-2005 DEER, Version 2.01, Measure ID DO3-907.

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
02	11/15/2019	Joseph Ling, AESC	Used data acquired by Frontier Energy to update baseline and measure energy and demand. Created new calculation workbook based on updated savings and using new SCE Workpaper Calculation Template.
01	08/31/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOFST105, Revision 5 (July 2016) SCE13CC003, Revision 2 (January 15, 2016) WPSDGENRCC0018, Revision 9 (Jun 26, 2012) Consensus reached among Cal TF members.
	10/10/2018 10/30/2018	Jennifer Holmes Cal TF Staff	Completed final revisions for submittal of version 01.