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**REFRIGERATION**  
**REACH-IN REFRIGERATOR OR FREEZER,  
COMMERCIAL**  
SWCR018-01

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**MEASURE NAME**

Reach-In Refrigerator or Freezer, Commercial

**STATEWIDE MEASURE ID**

SWCR018-01

**TECHNOLOGY SUMMARY**

This measure pertains to the purchase of a new or replacement with an energy-efficient commercial reach-in solid and glass door refrigerator or freezers, in vertical and chest configurations. In all categories, the refrigeration system must be built-in (packaged).

Reach-in refrigerators and freezers store perishable goods in supermarkets and other food retail and food service establishments. They are typically constructed from stainless steel and have a thick layer of insulation in the walls, doors, and floor. The cabinets have one to three doors made of either glass or steel and come in a variety of sizes with storage capabilities up to 72 ft<sup>3</sup>. These units are “self-contained” as they have an internal compressor for cooling rather than relying on an external compressor.

**MEASURE CASE DESCRIPTION**

The measure case is defined as an ENERGY STAR®-qualified commercial reach-in refrigerator or freezer that replaces a standard efficiency unit of the same configuration and capacity. Measure offerings are defined by configuration and internal volume (V), as specified in the ENERGY STAR Commercial Refrigerators and Freezers Program Requirements specified below.<sup>1</sup>

**Measure Case Specification – ENERGY STAR Requirements for Reach-In Refrigerators and Freezers (Version 4.0)**

Equipment Description (ft <sup>3</sup> )	Daily Energy Usage (kWh/day)
<b>Solid-Door Reach-In Refrigerator (VCS.SC.M)</b>	
0 < V < 15	≤ 0.022V* + 0.97
15 ≤ V < 30	≤ 0.066V + 0.31
30 ≤ V < 50	≤ 0.04V + 1.09
50 ≤ V	≤ 0.024V + 1.89
<b>Solid-Door Reach-In Freezer (VCS.SC.L)</b>	
0 < V < 15	≤ 0.21V + 0.9
15 ≤ V < 30	≤ 0.12V + 2.248
30 ≤ V < 50	≤ 0.285V – 2.703
50 ≤ V	≤ 0.142V + 4.445
<b>Glass-Door Reach-In Refrigerator (VCT.SC.M)</b>	
0 < V < 15	≤ 0.095V + 0.445
15 ≤ V < 30	≤ 0.05V + 1.12

<sup>1</sup> ENERGY STAR. 2016. "ENERGY STAR® Program Requirements Product Specification for Commercial Refrigerators and Freezers - Eligibility Criteria Version 4.0." Effective on March 27, 2017.

Equipment Description (ft <sup>3</sup> )	Daily Energy Usage (kWh/day)
$30 \leq V < 50$	$\leq 0.076V + 0.34$
$50 \leq V$	$\leq 0.105V - 1.111$
<b>Glass-Door Reach-In Freezer (VCT.SC.L)</b>	
$0 < V < 15$	$\leq 0.232V + 2.36$
$15 \leq V < 30$	
$30 \leq V < 50$	
$50 \leq V$	

V = internal volume in cubic feet.

## BASE CASE DESCRIPTION

The base case measure includes standard-efficiency, reach-in solid and glass door refrigerators and freezer are defined by the U.S. Department of Energy (DOE) federal requirements.<sup>2</sup> (See Code Requirements), as specified below.

### Base Case Specification— Federal DOE Requirements for Reach-In Refrigerators and Freezers, Effective March 2017

Equipment Description (ft <sup>3</sup> )	DOE Refrigeration Type Designation	DOE description	Daily Energy Usage (kWh/day)
Solid-Door Reach-In Refrigerator	VCS.SC.M	Vertical Closed Solid, Self-Contained, Medium temp	$\leq 0.05V^* + 1.36$
Solid-Door Reach-In Freezer	VCS.SC.L	Vertical Closed Solid, Self-Contained, Low temp	$\leq 0.22V + 1.38$
Glass-Door Reach-In Refrigerator	VCT.SC.M	Vertical Closed Transparent, Self-Contained, Medium temp	$\leq 0.1V + 0.86$
Glass-Door Reach-In Freezer	VCT.SC.L	Vertical Closed Transparent, Self-Contained, Low temp	$\leq 0.29V + 2.95$

V = internal volume in cubic feet.

## CODE REQUIREMENTS

Both commercial refrigerators and freezers must comply with federal energy use standards – the Energy Conservation Standards of the Code of Federal Regulations,<sup>3</sup> and the California Appliance Efficiency Regulations (Title 20). Title 20 aligns with the federal regulations, which are specified below.

### Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2016)	Section 1605.1(2), Table A-4, aligns with CFR	January 1, 2010
CA Building Energy Efficiency Standards – Title 24	None.	n/a
Federal Standards	10 CFR § 431.66	March 28, 2017

<sup>2</sup> Code of Federal Regulations at 10 CFR 431.66.

<sup>3</sup> Code of Federal Regulations at 10 CFR 431.66.

Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications, manufactured on or after March 1, 2017, shall have a daily energy usage that does not exceed usage specified in the table below.

**Federal DOE Requirements for Reach-In Refrigerators and Freezers**

Equipment Description (ft <sup>3</sup> )	DOE Refrigeration Type Designation	DOE description	Daily Energy Usage (kWh/day)
Solid-Door Reach-In Refrigerator	VCS.SC.M	Vertical Closed Solid, Self-Contained, Medium temp	≤ 0.05V*+1.36
Solid-Door Reach-In Freezer	VCS.SC.L	Vertical Closed Solid, Self-Contained, Low temp	≤ 0.22V+1.38
Glass-Door Reach-In Refrigerator	VCT.SC.M	Vertical Closed Transparent, Self-Contained, Medium temp	≤ 0.1V+0.86
Glass-Door Reach-In Freezer	VCT.SC.L	Vertical Closed Transparent, Self-Contained, Low temp	≤ 0.29V+2.95

V = internal volume in cubic feet.

The California Building Energy Efficiency Standards (Title 24) do not apply because solid door and class door reach-in refrigerators and freezers.

**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 for Investor-Owned Utilities**

Measure Application Type	Delivery Type	Sector
Normal replacement	NonUpStrm	Ag
Normal replacement	NonUpStrm	Ind
Normal replacement	NonUpStrm	Com
Normal replacement	PreRebDown	Ag
Normal replacement	PreRebDown	Ind

Measure Application Type	Delivery Type	Sector
Normal replacement	PreRebDown	Com
Normal replacement	DirInstall	Ag
Normal replacement	DirInstall	Ind
Normal replacement	DirInstall	Com
Normal replacement	PreRebUp	Ag
Normal replacement	PreRebUp	Ind
Normal replacement	PreRebUp	Com
New construction	NonUpStrm	Ag
New construction	NonUpStrm	Ind
New construction	NonUpStrm	Com
New construction	PreRebDown	Ag
New construction	PreRebDown	Ind
New construction	PreRebDown	Com
New construction	DirInstall	Ag
New construction	DirInstall	Ind
New construction	DirInstall	Com
New construction	PreRebUp	Ag
New construction	PreRebUp	Ind
New construction	PreRebUp	Com

### Eligible Products

Eligible products include ENERGY STAR®-qualified commercial reach-in refrigerators and freezers that replace a standard efficiency unit of the same configuration and capacity. There are 16 eligible measure offerings defined by configuration and internal volume, as specified in the ENERGY STAR Commercial Refrigerators and Freezers Program Requirements.<sup>4</sup>

### Measure Case Specification – ENERGY STAR Requirements for Reach-In Refrigerators and Freezers (Version 4.0)

Equipment Description (ft <sup>3</sup> )	Daily Energy Usage (kWh/day)
<b>Solid-Door Reach-In Refrigerator (VCS.SC.M)</b>	
0 < V < 15	≤ 0.022V* + 0.97
15 ≤ V < 30	≤ 0.066V + 0.31
30 ≤ V < 50	≤ 0.04V + 1.09
50 ≤ V	≤ 0.024V + 1.89
<b>Solid-Door Reach-In Freezer (VCS.SC.L)</b>	
0 < V < 15	≤ 0.21V + 0.9
15 ≤ V < 30	≤ 0.12V + 2.248
30 ≤ V < 50	≤ 0.285V – 2.703
50 ≤ V	≤ 0.142V + 4.445
<b>Glass-Door Reach-In Refrigerator (VCT.SC.M)</b>	
0 < V < 15	≤ 0.095V + 0.445
15 ≤ V < 30	≤ 0.05V + 1.12

<sup>4</sup> ENERGY STAR. 2016. "ENERGY STAR® Program Requirements Product Specification for Commercial Refrigerators and Freezers - Eligibility Criteria Version 4.0." Effective on March 27, 2017.

Equipment Description (ft <sup>3</sup> )	Daily Energy Usage (kWh/day)
$30 \leq V < 50$	$\leq 0.076V + 0.34$
$50 \leq V$	$\leq 0.105V - 1.111$
<b>Glass-Door Reach-In Freezer (VCT.SC.L)</b>	
$0 < V < 15$	$\leq 0.232V + 2.36$
$15 \leq V < 30$	
$30 \leq V < 50$	
$50 \leq V$	

V = internal volume in cubic feet.

#### Eligible Building Types

These measures are applicable for any existing commercial building type of any vintage.

#### Eligible Climate Zones

These measures are applicable in all California climate zones.

### PROGRAM EXCLUSIONS

Units with remote refrigeration systems do not qualify and used or rebuilt equipment is not eligible.

### DATA COLLECTION REQUIREMENTS

Data requirements are to be determined.

### USE CATEGORY

Commercial refrigeration (ComRefrig)

### ELECTRIC SAVINGS (kWh)

The annual unit energy savings (UES) was calculated as the difference between the baseline and measure case unit energy consumption (UEC) for each refrigerator and freezer configuration.

$$UES_{YEAR} = [UEC_{YEAR_{Base}} - UEC_{YEAR_{Measure}}]$$

$$UEC_{YEAR} = \text{Annual UEC, baseline or measure (kWh/year)}$$

$$UES_{YEAR} = \text{Annual UES (kWh/year)}$$

The UEC for a typical unit was derived by calculating the baseline and measure case daily energy usage for each configuration according to the equations in the Measure Case Description and Base Case Description, respectively.

The calculated annual unit energy consumption (UEC) was based on the equipment operation assumptions specified below. The nominal size and internal volume range are based on standard widths and each standard width may include multiple (French style) doors and/or multiple sections.

## Equipment Operation Assumptions

Parameter	Value	Source
Operating Hours/Day (hours)	24	Professional judgement
Operating Days/Year (days)	365	

A sample calculation showing the daily and annual energy savings of a Solid-Door Reach-In Refrigerator with total volume between 15 ft<sup>3</sup> and 29 ft<sup>3</sup> (15 < V < 29 ft<sup>3</sup>) is provided below.

$$\begin{aligned}
 \text{Volume (V)} &= 24 \text{ ft}^3 \\
 \text{Measure Case Daily Energy Usage} &= 0.066 \times V + 0.31 \text{ (See Measure Case Table)} \\
 &= 0.066 \times 24 + 0.31 = 1.89 \text{ kWh / day} \\
 \text{Measure Case Annual Energy Usage} &= (\text{Daily Energy Usage}) \times 365 \text{ days per year} \\
 &= 1.89 \text{ kWh / day} \times 365 \text{ days / year} = 691 \text{ kWh / year} \\
 \text{Baseline Daily Energy Usage} &= 0.05 \times V + 1.36 \text{ (See Base Case Table)} \\
 &= 0.05 \times 24 + 1.36 = 2.56 \text{ kWh / day} \\
 \text{Base Case Annual Energy Usage} &= (\text{Daily Energy Usage}) \times 365 \text{ days per year} \\
 &= 2.56 \text{ kWh / day} \times 365 \text{ days / year} = 934 \text{ kWh / year} \\
 \text{Annual Energy Savings} &= \text{Baseline Annual Usage} - \text{Measure Case Annual Usage} \\
 &= 934 - 691 \text{ kWh / year} = 243 \text{ kWh / year}
 \end{aligned}$$

## PEAK ELECTRIC DEMAND REDUCTION (KW)

The peak demand reduction was calculated by dividing the daily unit energy consumption (UEC) by the assumed hours of operation. It is assumed that this measure operates 24 hours per day, 365 days per year - within the Database of Energy Efficient Resources (DEER) peak period of 4 p.m. to 9 p.m. on weekdays<sup>5</sup> at a constant load throughout the day. The average and peak demand reduction calculations utilize the measured data of base case and measure case griddles specified for Electric Savings. The **average demand** (baseline or measure case) is equal to the daily unit energy consumption (UEC) divided by the assumed daily hours of operation.

$$\begin{aligned}
 \text{Demand}_{avg} &= \frac{\text{UEC}_{DAY} \text{ kWh}}{\text{E} \text{ HOUR}} \\
 \text{UEC}_{DAY} &= \text{Annual UEC, baseline or measure (kWh/year)} \\
 \text{E} \text{ HOUR} &= \text{Estimated operating hours per day (hrs)}
 \end{aligned}$$

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).

$$\text{PeakDemandReduction} = [(\text{Demand}_{avg,base} - \text{Demand}_{avg,measure}) \times \text{CDF}]$$

<sup>5</sup> California Public Utilities Commission (CPUC). 2018. *Resolution E-4952*. October 11. Op 1.

$$Demand_{avg} = \text{Average demand, base or measure case (kW)}$$

$$CDF = \text{Coincident demand factor}$$

The assumptions and inputs to calculate peak demand reduction are specified in the following table. A CDF is applied to conservatively estimate the peak demand reduction during the DEER peak period for each climate zone.

#### Demand Reduction Inputs

Parameter	Value	Source
Operating Hours/Day (hours)	24	Professional judgement
Operating Days/Year (days)	365	
Coincident demand factor (CDF)	1.0	

A sample calculation showing the daily and annual energy savings of a Solid-Door Reach-In Refrigerator with total volume between 15 ft<sup>3</sup> and 29 ft<sup>3</sup> (15 < V < 29 ft<sup>3</sup>) is provided below.

$$Volume (V) = 24 \text{ ft}^3$$

$$Measure \text{ Case Average Demand}$$

$$= Measure \text{ Daily Energy Usage} / 24 \text{ hrs}$$

$$= 1.89 / 24 = 0.079 \text{ kW}$$

$$Baseline \text{ Average Demand}$$

$$= Baseline \text{ Daily Energy Usage} / 24 \text{ hrs.}$$

$$= 2.56 / 24 = 0.107 \text{ kW}$$

$$Average \text{ Demand Reduction}$$

$$= (Baseline \text{ Average Demand} - Measure \text{ Case Average Demand})$$

$$= 0.107 \text{ kW} - 0.079 \text{ kW} = 0.028 \text{ kW}$$

$$Peak \text{ Demand Reduction}$$

$$= Average \text{ Demand Reduction} \times CDF$$

$$= 0.028 \times 1.0 = 0.028 \text{ kW}$$

#### 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 specified for this measure are specified below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures and is not applicable for reach-in commercial refrigerators and freezers.

#### Effective Useful Life and Remaining Useful Life

Parameter	Commercial Reach-In Refrigerator	Commercial Reach-In Freezer	Source
EUL (yrs)	12.0	12.0	California Public Utilities Commission (CPUC), Energy Division. 2014. "DEER2014-EUL-table-update_2014-02-05.xlsx."
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 estimated base case equipment cost was derived as the average of list prices of common models of major refrigeration appliance manufacturers obtained from the WebstaurantStore online restaurant supplier, as of Q1 2017.

#### Baseline Refrigerator and Freezer Material Costs <sup>6</sup>

Typical Appliance Description	Under-Counter	Single-Door	Double-Door	Triple-Door
Typical Nominal Size	1 door	1 door	2 doors	3 doors
Nominal Volume Range (ft <sup>3</sup> )	0 < V < 15	15 ≤ V < 30	30 ≤ V < 50	50 ≤ V
Solid-Door Reach-In Refrigerator	\$2,057.80	\$2,583.33	\$3,355.50	\$4,646.25
Solid-Door Reach-In Freezer	\$2,311.40	\$2,942.00	\$3,915.50	\$5,871.71
Glass-Door Reach-In Refrigerator	\$2,828.00	\$2,593.67	\$3,906.20	\$5,250.40
Glass-Door Reach-In Freezer (DOE 2017 Compliant) **	N/A	\$4,342.00	\$5,351.40	\$8,266.00

### MEASURE CASE MATERIAL COST (\$/UNIT)

The estimated measure case equipment cost for *all delivery types* was derived as the average of list prices of common models of major refrigeration appliance manufacturers obtained from the WebstaurantStore online restaurant supplier, as of Q1 2017.

#### Measure Refrigerator and Freezer Material Costs <sup>7</sup>

Typical Appliance Description	Under-Counter	Single-Door	Double-Door	Triple-Door
Typical Nominal Size	1 door	1 door	2 doors	3 doors
Nominal Volume Range (ft <sup>3</sup> )	0 < V < 15	15 ≤ V < 30	30 ≤ V < 50	50 ≤ V
Solid-Door Reach-In Refrigerators (Energy Star 4.0)	\$2,242.00	\$2,803.00	\$3,630.00	\$5,003.00
Solid-Door Reach-In Freezers (Energy Star 4.0)	\$2,409.00	\$3,316.20	\$4,435.80	\$6,509.00
Glass-Door Reach-In Refrigerators (Energy Star 4.0)	\$2,862.00	\$2,838.50	\$4,357.00	\$5,968.00

<sup>6</sup> Pacific Gas and Electric (PG&E). 2017. "PGECOFST123 Reach in Ref and Freezer Cost Analysis 2017.xlsx."

<sup>7</sup> Pacific Gas and Electric (PG&E). 2017. "PGECOFST123 Reach in Ref and Freezer Cost Analysis 2017.xlsx."

Typical Appliance Description	Under-Counter	Single-Door	Double-Door	Triple-Door
Glass-Door Reach-In Freezers (Energy Star 4.0)	N/A	\$4,470.00	\$5,650.50	\$8,790.00

### 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 NTG") 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	Commercial Reach-In Refrigerator	Commercial Reach-In Freezer	Source
NTG – Commercial	0.60	0.60	Itron, Inc. 2011. <i>DEER Database 2011 Update Documentation</i> . Prepared for the California Public Utilities Commission. Page 15-4 Table 15-3.
NTG – Industrial	0.60	0.60	
NTG - Agriculture	0.60	0.60	

## 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	Commercial Reach-In Refrigerator	Commercial Reach-In Freezer	Source
GSIA	1.0	1.0	California Public Utilities Commission (CPUC), Energy Division. 2013. <i>Energy Efficiency Policy Manual Version 5</i> . 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).

### 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	N/A
DEER Measure IDs Used	N/A
NTG	Source: DEER. The value of 0.60 is associated with NTG ID: <i>Com-Default&gt;2yrs, Agric-Default&gt;2yrs, and Ind-Default&gt;2yrs</i>
GSIA	Source: DEER. The value of 1.0 is associated with GSIA ID: <i>Def-GSIA</i>
EUL/RUL	Source: DEER. The EUL value of 12 years is associated with EUL IDs: <i>Cook-SDFreez and Cook-SDRef</i>

## REVISION HISTORY

## Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary
01	03/31/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: PGECOFST124 Revision 4 (Rev 3 on cover), March 2, 2017 PGECOFST123 Revision 3 (December 7, 2016) SCE13CC001 Revision 3 (January 26, 2016) WPSDGENRR0010 Revision 2.1 (May 29, 2015) Consensus reached among Cal TF members
	11/30/2018	Jennifer Holmes Cal TF Staff	Update with Rev 4 code and cost updates. Revisions for CPUC submittal.