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COMMERCIAL REFRIGERATION

MEDIUM OR LOW-TEMPERATURE DISPLAY CASE WITH DOORS

SWCR021-01

CONTENTS

MEASURE NAME

Medium or Low Temperature Display Case with Doors

STATEWIDE MEASURE ID

SWCR021-01

TECHNOLOGY SUMMARY

Low-temperature display cases are used to merchandise frozen food and ice cream. Medium-temperature display cases are used to merchandise dairy, deli, fish and meat products. The evaporator temperature in low-temperature cases is maintained between -40°F and 0°F; the evaporator temperature in medium-temperature refrigeration equipment is maintained between 0°F and 35°F.

The main benefit of replacing an open, multi-deck case with a new enclosed multi-deck case is the reduction in total cooling load due to reduced air infiltration. The *infiltration load* refers to the entrainment of warm and moist air from the sales area into the refrigerated space. The infiltration load accounts for more than 80% of the total cooling load of a multi-deck display case. Therefore, any reduction in infiltration load can reduce refrigeration compressor power demand and energy usage significantly. Note that installing a case with glass doors will likely result in an increase in anti-sweat heater (ASH) load.

MEASURE CASE DESCRIPTION

The measure case is defined as the replacement of an existing, open, vertical (or multi-deck) low-temperature or medium-temperature display cases with new, reach-in, glass door display case.

Measure Case Specification

Statewide Measure Offering ID	Measure Offering Description
SWCR021A	New Display Case with Doors, MT
SWCR021B	New Display Case with Doors, LT

BASE CASE DESCRIPTION

The base case is defined as existing open, vertical, low-temperature or medium-temperature display case.

CODE REQUIREMENTS

Applicable state and federal codes for this measure are specified below.

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20	None	n/a
CA Building Energy Efficiency Standards – Title 24	None	n/a
Federal Standards – Code of Federal Regulations (2012)	10 CFR Sect 431.66	March 28, 2104

Both the base case and measure equipment must comply with the Code of Federal Regulations, Title 10 Section 431.66 (2012). The standard established a maximum daily energy consumption (MDEC) as follows, when tested in compliance with ARI Standard 1200-2006:

Case Type	Maximum Daily Energy Consumption (MDEC)
Medium-temperature display case with doors	*0.22 × TDA -Total Display Area (ft²) + 1.95 kWh/day*
Low-temperature display cases with doors	*0.56 + TDA (ft²) + 2.61 kWh/day*
Vertical, open, multi-deck display case, medium temperature	*0.82 × TDA (ft²) + 4.07 kWh/day*
Vertical, open, multi-deck display case, low temperature	*0.82 × TDA (ft²) + 4.07 kWh/day*

The standard does not specify requirements for specific case components (evaporator fan motors, case lighting, insulation, evaporator coil, air curtain).

This measure is not governed by California standards. Section 1605.3 of the California Appliance Efficiency Regulations (Title 20), pertains new appliances sold or offered for sale in California but does not to vertical open refrigerated display cases.

This measure does not fall under the California Building Energy Efficiency Standards (Title 24). Section 126 of the 2016 standard applies to refrigeration systems in refrigerated warehouses but does not apply to display equipment found in retail food establishments.

NORMALIZING UNIT

Linear feet (Len-ft)

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	Com

Eligible Products

This measure is applicable for supermarkets and grocery stores with stand-alone and/or multiplex compressor racks that provide refrigeration to remote display cases and walk-in coolers/freezers. This measure is applicable to supermarkets and grocery stores with both medium-temperature and low-temperature open multi-deck refrigeration cases. Requirements include:

- Must replace an existing, open, multi-deck display case with a new reach-in unit with doors, electronically commutated motor (ECM) evaporator fan(s), and LED lighting.
- Medium-temperature cases must have no heat in the door. Heat is allowed in the frames of medium temperature cases.
- Low-temperature case door and frame heaters combined may not consume more than 50 W/ft of case length.
- The new case length must be less than or equal to the original case length.
- This measure is only for display cases served by a remote refrigeration system.

Eligible Building Types and Vintages

This measure is applicable in any existing commercial building of any vintage. To determine energy savings, the new consolidated DEER vintages definitions were used. Energy savings are reported for the "Ex" vintage that included years 2003, 2007, 2001, and 2015.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

Specialty deli cases, custom coolers/freezers, and walk-in boxes with reach-in doors are not eligible.

Refurbished cases are not eligible unless compliant with the 2012 Federal Efficiency Standards (see Code Requirements).

Salvage, disposal or photographic records of replaced equipment should be part of program application requirements when early replacement or open-to-closed case conversion savings are being utilized to ensure the correct baseline is assumed for these measures.

Display case replacements that are part of large-scale store remodels and any new construction projects should be revised to be custom measures. Large-scale remodels are defined as any project involving 50% of the linear feet of refrigerated casework or 32 linear feet of casework replacements, whichever is less.

DATA COLLECTION REQUIREMENTS

Data collection requirements are to be determined.

USE CATEGORY

Commercial refrigeration (ComREfrig)

ELECTRIC SAVINGS (kWh)

The energy savings and demand reduction for this measure are based on the replacement of an existing, open, vertical (multi-deck), low-temperature or medium-temperature display cases with a similar reach-in glass door display case. Based on industry practice, the medium-temperature retrofit incorporates additional case lighting to improve product visibility. Due to the addition of the LED lights the overall case lighting power density for the medium-temperature case was reduced. The low-temperature baseline case includes LED lighting and no change was made to the power density per foot. Replacing an open display case with a reach-in glass door display case will reduce the infiltration load significantly, resulting in savings on the refrigeration cooling load and space heating load.

Assumptions

The following assumptions were established for the calculations of the energy (and demand) impacts of this measure:

- The building simulation models were generated from the Database of Energy Efficient Resources (DEER) measure analysis tool within eQUEST 3-61R. The DEER model simulates a grocery store with a multiplex-compressor system for the refrigerated display cases. Since single-compressor systems are generally slightly less efficient than multiplex-compressor systems, only multiplex systems were analyzed as a conservative estimate of savings. To be conservative, it was assumed that the generated energy savings of this measure will also be applied to display cases with single-compressor systems.
- This measure is applicable for display cases located within a space with heating, cooling, and humidity controls. The unit energy savings are represented per linear foot of the display case. The building simulation models were generated for a grocery store. Since the heat gain to a display case mainly depends on the temperature maintained for the display case and the surrounding space temperature, it is assumed that the building types would not have significant impact on the energy savings. Thus, the resulting savings of the grocery store model is applied to all other building types considered in this work paper.

Base Case and Measure Case Energy Use Simulations

The baseline and measure case energy consumption were modeled using the DEER 2020 Grocery Prototype eQUEST models. The models were generated from MAS Control V3.00.19. That information can be identified in the database as measures D03-214 and D03-215.

Baseline Models. Because there were no updates to the prototype store for Vintage 2011 and earlier, the original MAS Control V3.00.19 models were used for 1975, 1985, 1996, 2003, 2007, and 2011 vintages.

For vintages 2015 and newer the updated DEER prototype models were used. These new prototypes were originally modeled with reach-in MT cases and thus they were converted to open cases and have the same length as the original MAS Control V3.00.19 models. Infiltration load and conduction load values from the MAS Control V3.00.19 models were used for all vintages. Lighting power and fan power from MAS Control V3.00.19 models were used in vintage 2011 and earlier whereas for vintage 2015 and newer, fan and lighting power are converted from kW/door to kW/len. Thus, there would be no savings from fans and lighting in these vintages.

Measure Case Models. The MT/LT open to reach-in case measures were modeled by changing open cases to door cases and adjusting infiltration load, conduction load, lighting power, fan power, heater power and control of the following cases:

Medium Temperature: MT_DeliPasta, MT_Meat3, MT_Dairy1 – 128 ft total

Low Temperature: LT_FF1ReachinCase, LT_FF2ReachinCase, LT_ICReachinCase – 283 ft total

All keyword and value changes are documented in "Open To RI keyword changes.xlsx" spreadsheet.[1]

Summary of Modeled Medium-Temperature Vertical Display Cases

Component	Medium Temperature Open Multi Deck Values (Baseline Model)	Medium Temperature Reach in Multi Deck Values (Measure Model)
Evaporator Fan Power	0.0147 (kW/ft) *	0.0150 (kW/dr)
Lighting Power	0.0369 (kW/ft) *	0.02810 (kW/dr)
Anti-Sweat Power	0.0000 (kW/ft)	0.01783 (kW/dr)
Infiltration Load	1058 (Btu/hr-ft)	153.33 (Btu/hr-dr)
Conduction Load	77.8 (Btu/hr-ft)*	273.33 (Btu/hr-dr)
Total Line-Up Length	128 (ft)	50 (doors)

Summary of Modeled Low-Temperature Vertical Display Cases

Component	Low Temperature Open Multi Deck Values (Baseline Model)	Low Temperature Reach in Multi Deck Values (Measure Model)
Evaporator Fan Power	0.01788 (kW/ft) *	0.01976 (kW/dr)
Lighting Power	0.0179 (kW/ft) *	0.0478 (kW/dr)
Anti-Sweat Power	0.04525 (kW/ft)	0.09568 (kW/dr)
Infiltration Load	1550 (Btu/hr-ft)	65.84 (Btu/hr-dr)
Conduction Load	325 (Btu/hr-ft)*	600 (Btu/hr-dr)
Total Line-Up Length	283 (ft)	109 (doors)

[1] Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01 Model Files.zip."

Unit Energy Savings Calculation

Once the base case and measure case model simulations were completed, the energy savings and demand reduction were determined. Total energy savings were calculated as the difference between the baseline and measure case total energy consumption. The unit energy savings (UES), in kWh/yr-ft for electricity (and therm/yr-ft for natural gas), were calculated by dividing the total energy savings by the total line-up length of the display cases. Dividing the length of cases by the number of doors in the DEER grocery prototype yielded an approximate unit door length of 2.67 ft per door.

PEAK ELECTRIC DEMAND REDUCTION (KW)

Peak demand reduction was determined from the baseline and measure case eQUEST energy models described in Electric Savings. Peak demand reduction was calculated as the difference between the baseline and measure case peak demand, represented during the peak demand hours of 4:00 p.m. to 9:00 p.m.[2] The unit demand reduction (kW/ft), was calculated by dividing the total demand reduction by the total line-up length of the display cases.

GAS SAVINGS (THERMS)

Gas unit energy savings (UES) were determined from the baseline and measure case eQUEST energy models described in Electric Savings. Because there is no code, the gas energy savings for this measure represents interactive effects of the refrigeration system with the HVAC system.

LIFE CYCLE

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The methodology to calculate the RUL conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”[3] This approach provides a reasonable RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.[4] Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised add-on measures so that the EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component.” [5]

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

[3] California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32.

[4] KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc.

[5] California Public Utilities Commission (CPUC). 2016. *Resolution E-4807.* December 16. Page 13.

The EUL and RUL specified below. Note that RUL is only applicable for add-on equipment and accelerated replacement measures and is not applicable for this measure.

Effective Useful Life and Remaining Useful Life

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

BASE CASE MATERIAL COST ($/UNIT)

The base case equipment costs were retrieved from the U.S. Department of Energy (DOE) cost-effectiveness analysis used to develop the federal standards for refrigerated display cases. Costs were converted to 2019 values by applying an adjustment factor developed from the RSMeans historical cost index.[6]

Base Case Material Cost Inputs

Input	Value	Source
Baseline code-compliant display case ($/len-ft)	$837.05	U.S. Department of Energy (DOE). 2014. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Commercial Refrigeration Equipment.* Washington DC: US Department of Energy.
	$593.82	
2019 cost conversion factor	1.35	Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01_Cost Update.xlsx." See "Table 1" tab.

MEASURE CASE MATERIAL COST ($/UNIT)

The measure case equipment costs were retrieved from the U.S. Department of Energy (DOE) cost-effectiveness analysis used to develop the federal standards for refrigerated display cases. Costs were converted to 2019 values by applying an adjustment factor developed from the RSMeans historical cost index.[7]

Base Case Material Cost Inputs

Input	Value	Source
Baseline code-compliant display case ($/len-ft)	$1,048.32	U.S. Department of Energy (DOE). 2014. *Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment. Commercial Refrigeration Equipment.* Washington DC: US Department of Energy.
	$915.77	
2019 cost conversion factor	1.35	Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01_Cost Update.xlsx." See "Table 1" tab.

[6] Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01_Cost Update.xlsx."

[7] Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01_Cost Update.xlsx."

BASE CASE LABOR COST ($/UNIT)

The base case labor costs were retrieved from the U.S. Department of Energy (DOE) cost-effectiveness analysis used to develop the federal standards for refrigerated display cases. Costs were converted to 2019 values by applying an adjustment factor developed from the RSMeans historical cost index. [8]

MEASURE CASE LABOR COST ($/UNIT)

The installation is assumed to be same for both base case and measure case display cases, See Base Case Labor Cost.

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 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 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.

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

Parameter	GSIA	Source
GSIA - Default	1.00	California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31.

NON-ENERGY IMPACTS

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

[8] Pacific Gas & Electric Company (PG&E). 2019. "SWCR021-01_Cost Update.xlsx."

DEER DIFFERENCES ANALYSIS

This section provides a summary of inputs and methods based upon 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
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	This measure is not in DEER
DEER Measure IDs Used	n/a
NTG	Source: DEER. The value of 0.60 is associated with NTGR IDs: *Com-Default>2yrs*
GSIA	Source: DEER. The value of 1.0 is associated with GSIA ID: *Def-GSIA*
EUL/RUL	Source: DEER. The EUL value of 12 years is associated with EUL ID: *GrocDisp-FixtDoors*

REVISION HISTORY

Measure Characterization Revision History

Revision Number	Revision Complete Date	Primary Author, Title, Organization	Revision Summary and Rationale for Revision
01	05/23/2019	Adan Rosillo, PG&E	Draft of consolidated text for this statewide measure is based upon: PGECOREF104, Revision 6 (March 30, 2016) Consensus reached among Cal TF members.
	06/07/2019	Jennifer Holmes, Cal TF Staff	Revisions for submittal of version 01.