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| Refrigeration  hIGH eFFICIENCY REFRIGERATED DISPLAY CASES  SWcr014-02 |

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Measure Name

High Efficiency Refrigerated Display Cases

Statewide Measure ID

SWCR014-02

Technology Summary

This measure addresses eighteen classes of display case commercial refrigerators and freezers with remote condensing units or self-contained condensing units designed for holding temperature and with a solid, transparent, or open display. Measure offerings were selected based on offerings from the predecessor IOU workpapers and in this revision, additional measure offerings were added for equipment classes with significant representation of Title 10 compliant units in the U. S. Department of Energy (DOE) Compliance Certification Database. Commercial refrigerated display cases are defined as either a medium-temperature with an operating temperature ≥ 32 °F or as a low-temperature case with an operating temperature < 32 °F. Such display cases are utilized in a variety of building types, including grocery stores, restaurants, schools, lodging facilities hospitals, etc., although they are predominantly found in grocery stores, convenience stores, and restaurants. Medium-temperature display cases are used to stock dairy, deli, fish, and meat. Low-temperature display cases are used to stock frozen food and ice cream.

The eighteen equipment classes of display cases included in this measure are summarized below.

Summary of Refrigerated Display Case Classification [[1]](#footnote-1)

| **Operating Mode Designation** | **Equipment Family** | **Equipment Family Designation** | **Sample Equipment Family Image** | **Temperature Designation** | **Operating Temp.** | **Equipment Class Designation** |
| --- | --- | --- | --- | --- | --- | --- |
| Remote Condensing (RC) | Vertical Open | VOP |  | M (38 °F) | ≥ 32 °F | VOP.RC.M |
| Semi vertical Open | SVO |  | M (38 °F) | ≥ 32 °F | SVO.RC.M |
| Horizontal Open | HZO |  | L (0 °F) | < 32 °F | HZO.RC.L |
| Vertical Closed Transparent | VCT |  | M (38 °F) | ≥ 32 °F | VCT.RC.M |
| L (0 °F) | < 32 °F | VCT.RC.L |
| Service Over Counter | SOC |  | M (38 °F) | ≥ 32 °F | SOC.RC.M |
| L (0 °F) | < 32 °F | SOC.RC.L |
| Self-Contained (SC) | Horizontal Closed Transparent | HCT |  | L (0 °F) | < 32 °F | HCT.SC.L |
| M (38 °F) | ≥ 32 °F | HCT.SC.M |
| I (-15 °F) | ≤ -5 °F | HCT.SC.I |
| Horizontal Closed Solid | HCS |  | M (38 °F) | ≥ 32 °F | HCS.SC.M |
| L (0 °F) | < 32 °F | HCS.SC.L |
| Vertical Closed Solid | VCS |  | M (38 °F) | ≥ 32 °F | VCS.SC.M |
| L (0 °F) | < 32 °F | VCS.SC.L |
| Vertical Closed Transparent | VCT |  | M (38 °F) | ≥ 32 °F | VCT.SC.M |
| L (0 °F) | < 32 °F | VCT.SC.L |
| Service Over Counter | SOC |  | M (38 °F) | ≥ 32 °F | SOC.SC.M |
| L (0 °F) | < 32 °F | SCO.SC.L |
| Semi vertical Open | SVO |  | M (38 °F) | ≥ 32 °F | SVO.SC.M |
| L (0 °F) | < 32 °F | SVO.SC.L |
| Vertical Open | VOP |  | M (38 °F) | ≥ 32 °F | VOP.SC.M |
| L (0 °F) | < 32 °F | VOP.SC.L |

A 2009 US Department of Energy (DOE) study[[2]](#footnote-2) documented the energy consumption of commercial refrigeration equipment in the U.S. and evaluated the energy savings potential of various technologies and energy efficiency measures. The study shows that commercial refrigeration represented 4.1% to 6.3% of total primary energy used in commercial buildings in 2008 and 2006, respectively; while 56% of the commercial refrigeration energy consumption was used for supermarket refrigeration in 2008. The study revealed that the energy-savings opportunities could result in a potential savings of 17% for display cases.

Refrigerated display case efficiency is dependent on the selected design options for equipment manufacturing. When higher efficiency design options are selected, the display case will result in less energy consumption. DOE Technical Support Document[[3]](#footnote-3) provides details of applicable design options of each display case class. For example, some design options for display cases include brushless DC (a.k.a. ECM) motors and permanent split capacity evaporator fan motors, which are more efficient than the baseline shaded pole motors; and some include LED lighting, which is more efficient than T8 florescent lighting.

Measure Case Description

This measure is defined as the installation of each of the eighteen classes of refrigerated display cases shown in the Technology Summary, representing thirty-five different configurations that exceed the Code of Federal Regulations standard[[4]](#footnote-4) by a minimum prescribed percentage (effective March 27, 2017). The measure case, existing condition, code scenarios are defined below.

Summary of Measure Case, Existing Condition, Code, and Industry Standard Practice Scenarios

| **Case** | **Description of Typical Scenario** |
| --- | --- |
| Measure Case | This measure includes display cases with a rated daily energy consumption (DEC) that is at least a minimum prescribed percentage less than the Maximum Daily Energy Consumption (MDEC), permissible under the Code of Federal Regulations standard, effective March 27, 2017. The prescribed percentage for each equipment class is identified below.  Measure case selection (and performance levels) are based on the average of all available equipment units performing better than Code (Title 10), which represents the higher efficiency levels. |
| Existing Condition | Display cases with efficiency minimally compliant with Code of Federal Regulations standard, effective September 1, 2012. (See Code Requirements.) The existing condition is applicable to all remote condensing units, and only one self-contained unit as listed under September 1, 2012 effective date. |
| Code/Standard | Display cases with efficiency minimally compliant with Code of Federal Regulation standards, effective March 27, 2017. See Code Requirements. |
| Industry Standard Practice | Not applicable. |

**Summary of Measure Offerings**

|  |  |  |
| --- | --- | --- |
| **Offering ID** | **Existing Case** | **Measure Description** |
| A | Standard Display Case, VOP.RC.M, < =30 ft2 | 16% Efficient, Display Case VOP.RC.M, < =30 ft2 |
| B | Standard Display Case, VOP.RC.M, > 30 ft2 | 16% Efficient, Display Case VOP.RC.M, > 30 ft2 |
| C | Standard Display Case, SVO.RC.M, < =25 ft2 | 12% Efficient, Display Case SVO.RC.M, < =25 ft2 |
| D | Standard Display Case, SVO.RC.M, >25 ft2 and <=75 ft2 | 12% Efficient, Display Case SVO.RC.M, >25 ft2 and <=75 ft2 |
| E | Standard Display Case, SVO.RC.M, >75 ft2 | 12% Efficient, Display Case SVO.RC.M, >75 ft2 |
| F | Standard Display Case, HZO.RC.L, <= 35 ft2 | 10% Efficient, Display Case HZO.RC.L, <= 35 ft2 |
| G | Standard Display Case, HZO.RC.L, > 35 ft2 | 10% Efficient, Display Case HZO.RC.L, > 35 ft2 |
| H | Standard Display Case, VCT.RC.M, <= 15 ft2 | 21% Efficient, Display Case VCT.RC.M, <= 15 ft2 |
| I | Standard Display Case, VCT.RC.M, >15 ft2 and <=50 ft2 | 21% Efficient, Display Case VCT.RC.M, >15 ft2 and <=50 ft2 |
| J | Standard Display Case, VCT.RC.M, >50 ft2 | 21% Efficient, Display Case VCT.RC.M, >50 ft2 |
| K | Standard Display Case, VCT.RC.L, <= 45 ft2 | 7% Efficient, Display Case VCT.RC.L, <= 45 ft2 |
| L | Standard Display Case, VCT.RC.L, > 45 ft2 | 7% Efficient, Display Case VCT.RC.L, > 45 ft2 |
| M | Standard Display Case, HCT.SC.L, <= 20 ft3 | 18% Efficient, Display Case HCT.SC.L, <= 20 ft3 |
| N | Standard Display Case, HCT.SC.L, > 20 ft3 | 18% Efficient, Display Case HCT.SC.L, > 20 ft3 |
| P | Standard Display Case, HCS.SC.M, <=100 ft3 | 23% Efficient, Display Case HCS.SC.M, <=100 ft3 |
| Q | Standard Display Case, HCT.SC.I, <= 10 ft2 | 22% Efficient, Display Case HCT.SC.I, <= 10 ft2 |
| R | Standard Display Case, HCT.SC.I, > 10 ft2 | 22% Efficient, Display Case HCT.SC.I, > 10 ft2 |
| S | Standard Display Case, VCS.SC.M, <= 30 ft3 | 23% Efficient, Display Case VCS.SC.M, <= 30 ft3 |
| T | Standard Display Case, VCS.SC.M, > 30 ft3 | 23% Efficient, Display Case VCS.SC.M, > 30 ft3 |
| U | Standard Display Case, HCS.SC.L, <= 50 ft3 | 17% Efficient, Display Case HCS.SC.L, <= 50 ft3 |
| V | Standard Display Case, VCS.SC.L, <= 30 ft3 | 15% Efficient, Display Case VCS.SC.L, <= 30 ft3 |
| W | Standard Display Case, VCS.SC.L, > 30 ft3 | 15% Efficient, Display Case VCS.SC.L, > 30 ft3 |
| X | Standard Display Case, HCT.SC.M, <= 50 ft3 | 25% Efficient, Display Case HCT.SC.M, <= 50 ft3 |
| Y | Standard Display Case, VCT.SC.M, <= 15 ft3 | 14% Efficient, Display Case VCT.SC.M, <= 15 ft3 |
| Z | Standard Display Case, VCT.SC.M, >15 ft3 and <=50 ft3 | 14% Efficient, Display Case VCT.SC.M, >15 ft3 and <=50 ft3 |
| AA | Standard Display Case, VCT.SC.M, >50 ft3 | 14% Efficient, Display Case VCT.SC.M, >50 ft3 |
| AB | Standard Display Case, VCT.SC.L, <= 15 ft3 | 14% Efficient, Display Case VCT.SC.L, <= 15 ft3 |
| AC | Standard Display Case, VCT.SC.L, >15 ft3 and <=75 ft3 | 14% Efficient, Display Case VCT.SC.L, >15 ft3 and <=75 ft3 |
| AD | Standard Display Case, VCT.SC.L, >75 ft3 | 14% Efficient, Display Case VCT.SC.L, >75 ft3 |
| AE | Standard Display Case, SOC.RC.M, <=50 ft2 | 20% Efficient, Display Case SOC.RC.M, <=50 ft2 |
| AF | Standard Display Case, SOC.RC.M, >50 ft2 | 20% Efficient, Display Case SOC.RC.M, >50 ft2 |
| AG | Standard Display Case, SOC.SC.M, <=75 ft2 | 22% Efficient, Display Case SOC.SC.M, <=75 ft2 |
| AH | Standard Display Case, SVO.SC.M, <=75 ft2 | 15% Efficient, Display Case SVO.SC.M, <=75 ft2 |
| AI | Standard Display Case, SVO.SC.M, >75 ft2 | 15% Efficient, Display Case SVO.SC.M, >75 ft2 |
| AJ | Standard Display Case, VOP.SC.M, <=75 ft2 | 13% Efficient, Display Case VOP.SC.M, <=75 ft2 |

Base Case Description

The base case for a *normal replacement installation* scenario is defined by the federal standard set in Title 10, effective March 27, 2017. See Measure Case Description and Code Requirements.

Code Requirements

This high efficiency display cases are subject to the standards stipulated in the Code of Federal Regulations, as specified below. California state standards are not applicable.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Federal Standards – Code of Federal Regulations | Title 10, Chapter II, Subchapter D, Part 431, Subpart C, §431.66 (e) (1) | March 27, 2017 |
| CA Appliance Efficiency Regulations – Title 20 | n/a | n/a |
| CA Building Energy Efficiency Standards – Title 24 | n/a | n/a |

**Code of Federal Regulations Title 10, Chapter II, Subchapter D, Part 431, Subpart C, §431.66 (e)(1)[[5]](#footnote-5)** requires the following:

*(e) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications and with solid or transparent doors; commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and with transparent doors; commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after March 27, 2017, shall have a daily energy consumption (in kilowatt-hours per day) that does not exceed the levels specified:*

For Equipment Other than Hybrid Equipment, Refrigerator/Freezers, or Wedge Cases

| **Condensing Unit Configuration** | **Equipment  Category** | **Equipment Family** | **Rating Temp. (°F)** | **Operating Temp. (°F)** | **Equip. Class Designation** | **Max. Daily Energy Use (kWh/day)** |
| --- | --- | --- | --- | --- | --- | --- |
| Remote (RC) | Remote Condensing Commercial Refrigerators and Commercial Freezers | Vertical Open (VOP) | 38 (M) | ≥32 | VOP.RC.M | 0.64 × TDA[[6]](#footnote-6) + 4.07. |
| Semi vertical Open (SVO) | 38 (M) | ≥32 | SVO.RC.M | 0.66 × TDA + 3.18. |
| Horizontal Open (HZO) | 0 (L) | <32 | HZO.RC.L | 0.55 × TDA + 6.88. |
| Vertical Closed Transparent (VCT) | 38 (M) | ≥32 | VCT.RC.M | 0.15 × TDA + 1.95. |
| 0 (L) | <32 | VCT.RC.L | 0.49 × TDA + 2.61. |
| Service Over Counter (SOC) | 38 (M) | ≥32 | SOC.RC.M | 0.44 x TDA + 0.11 |
| 0 (L) | <32 | SOC.RC.L | 0.93 x TDA + 0.22 |
| Self-Contained (SC) | Self-Contained Commercial Refrigerators and Commercial Freezers With Doors | Horizontal Closed Transparent (HCT) | 0 (L) | <32 | HCT.SC.L | 0.08 × V[[7]](#footnote-7) + 1.23. |
| 38 (M) | ≥32 | HCT.SC.M | 0.06 x V + 0.37 |
| Horizontal Closed Solid (HCS) | 38 (M) | ≥32 | HCS.SC.M | 0.05 × V + 0.91. |
| 0 (L) | <32 | HCS.SC.L | 0.06 x V + 1.12 |
| Vertical Closed Transparent (VCT) | 38 (M) | ≥32 | VCT.SC.M | 0.1 x V + 0.86 |
| 0 (L) | <32 | VCT.SC.L | 0.29 x V + 2.95 |
| Vertical Closed Solid (VCS) | 38 (M) | ≥32 | VCS.SC.M | 0.05 x V + 1.36 |
| 0 (L) | <32 | VCS.SC.L | 0.22 x V + 1.38 |
| Semi vertical Open (SVO) | 38 (M) | ≥32 | SVO.SC.M | 1.7 x TDA + 4.59 |
| 0 (L) | <32 | SVO.SC.L | 4.26 x TDA + 11.51 |
| Commercial Ice-Cream Freezers | Horizontal Closed Transparent (HCT) | −15 (I) | ≤−5 | HCT.SC.I | 0.56 × TDA + 0.43. |
| Self-Contained Commercial Refrigerators and Commercial Freezers Without Doors | Vertical Open (VOP) | 38 (M) | ≥32 | VOP.SC.M | 1.69 x TDA + 4.71 |
| 0 (L) | <32 | VOP.SC.L | 4.25 x TDA + 11.82 |

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 | DnDeemDI | Com |
| Normal Replacement | DnDeemed | Com |
| Normal Replacement | UpDeemed | Com |
| Normal Replacement | DnDeemDI | Ag |
| Normal Replacement | DnDeemed | Ag |
| Normal Replacement | UpDeemed | Ag |
| Normal Replacement | DnDeemDI | Ind |
| Normal Replacement | DnDeemed | Ind |
| Normal Replacement | UpDeemed | Ind |
| New Construction | DnDeemDI | Com |
| New Construction | DnDeemed | Com |
| New Construction | UpDeemed | Com |
| New Construction | DnDeemDI | Ag |
| New Construction | DnDeemed | Ag |
| New Construction | UpDeemed | Ag |
| New Construction | DnDeemDI | Ind |
| New Construction | DnDeemed | Ind |
| New Construction | UpDeemed | Ind |

Eligible Products

The new display cases must be one of the following eighteen classes specified below.

Eligible High-Efficiency Display Cases

|  |  |
| --- | --- |
| **Equipment Class Designation** | **Description** |
| *VOP.RC.M* | Vertical Open, Remote Condensing Commercial Refrigerators |
| *SVO.RC.M* | Semi vertical Open, Remote Condensing Commercial Refrigerators |
| *HZO.RC.L* | Horizontal Open, Remote Condensing Commercial Freezers |
| *VCT.RC.L* | Vertical Closed Transparent, Remote Condensing Commercial Freezers |
| *VCT.RC.M* | Vertical Closed Transparent, Remote Condensing Commercial Refrigerators |
| *VCT.SC.M* | Vertical Closed Transparent, Self-Contained Commercial Refrigerators |
| *VCT.SC.L* | Vertical Closed Transparent, Self-Contained Commercial Freezers |
| *VCS.SC.M* | Vertical Closed Solid, Self-Contained Commercial Refrigerators |
| *VCS.SC.L* | Vertical Closed Solid, Self-Contained Commercial Freezers |
| *HCT.SC.M* | Horizontal Closed Transparent, Self-Contained Commercial Refrigerators with Doors |
| *HCT.SC.L* | Horizontal Closed Transparent, Self-Contained Commercial Freezers with Doors |
| *HCS.SC.M* | Horizontal Closed Solid, Self-Contained Commercial Refrigerators with Doors |
| *HCS.SC.L* | Horizontal Closed Solid, Self-Contained Commercial Freezers with Doors |
| *HCT.SC.I* | Horizontal Closed Transparent, Self-Contained Commercial Ice-Cream Freezers |
| *SOC.RC.M* | Service Over Counter, Remote Condensing Commercial Refrigerators |
| *SOC.SC.M* | Service Over Counter, Self-Contained Commercial Refrigerators with Doors |
| *SVO.SC.M* | Semi-vertical Open, Self-Contained Commercial Refrigerators without Doors |
| *VOP.SC.M* | Vertical Open, Self-Contained Commercial Refrigerator without Doors |

To qualify for incentive, the following requirements must be met:

Must purchase a high efficiency display case, with a rated daily energy consumption (DEC) that is the prescribed percentage efficiency at least above the Maximum Daily Energy Consumption (MDEC) permissible under the Code of Federal Regulations, effective March 27, 2017. Display case specification must be provided to support this requirement.

Two sources for the display case specification are:

U. S. Department of Energy (DOE) Compliance Certification Database.[[8]](#footnote-8) See the Product Group of “Refrigeration Equipment - Commercial, Single Compartment”. The specification includes the following certified values: brand name and model number, equipment category description and condensing unit configuration description, total display area (TDA) or volume, and calculated MDEC.

ENERGY STAR Certified Commercial Refrigerators and Freezers database.[[9]](#footnote-9) The specification includes the following certified values: brand name and model number, equipment category description and condensing unit configuration description, total display area (TDA) or volume, and calculated MDEC

Manufacturer specifications that include: brand name and model number, equipment category description and condensing unit configuration description, total display area (TDA) or volume, and tested MDEC

Documentation of the *existing condition* must include model number(s), serial number(s), or other information sufficient to show a manufacture date *before* March 27, 2017.

Eligible Building Types

This measure is applicable for any commercial building types.

Eligible Climate Zones

This measure is applicable in all California climate zones.

Program Exclusions

This measure excludes display cases with a rated daily energy consumption (DEC) that is not at least prescribed percentage less than the Maximum Daily Energy Consumption (MDEC), permissible under the Code of Federal Regulations, effective March 27, 2017.

National chain supermarket or national chain convenience stores are not eligible for the 2012 baseline.

Data Collection Requirements

Based on the manufacturer survey[[10]](#footnote-10) summarized for this measure, the U.S. Department of Energy (DOE) and ENERGY STAR databases used for this measure accurately represent manufacturer data. Since the databases are updated regularly upon manufacturer submission, it is suggested that the DOE and ENERGY STAR databases be reviewed periodically for any significant data updates.

The 2017 Code of Federal Regulations provides standards for a total of 49 equipment classes of which 18 case classes are included in this measure. As of November 4, 2020, these 18 case classes account of 94% of 25,963 products listed in the U.S. Department of Energy (DOE) Compliance Certification database. Future updates to this measure should consider incorporating DOE database updates with significant representation from the remaining 31 case classes.

Use Category

Commercial refrigeration

Electric Savings (kWh)

Performance and specifications of 25,963 display cases were extracted from the Refrigeration Equipment database of the U.S. Department of Energy (DOE) Compliance Certification Database[[11]](#footnote-11)[[12]](#footnote-12) to derive the unit energy savings (UES) of this measure.

An example of data evaluation of VOP.RC.M is presented in the following:

A total of 3,806 VOP.RC.M display cases with different makes and models were extracted from the DOE database.

Based on the reported daily energy consumption (DEC) and total display area (TDA) rating, and the 2017 code baseline MDEC equation, 3,606 of the 3,806 cases (95%) were determined to be more efficient than the 2017 federal code baseline with an overall average of 16% lower DEC. The 16% was based on the following:

Where:

To determine if the calculated average product performance score was an acceptable performance threshold for the equipment class, the number of qualifying units in the DOE Database was evaluated to ensure that units qualify at all size ranges for the measure.

The maximum and minimum TDAs 125 ft2 and 6 ft2, respectively. Where an equipment class included products with a wide range of sizes (i.e. TDA or V) as indicated by a coefficient of variation () greater than 0.3, the products were grouped by size into two or more subclasses (a.k.a. size bins). An algorithm was followed to define the size bins for a given equipment class: Start with one bin for all sizes. Calculate for all products in the bin. If , then split the bin by inserting a new “split point” *x* such that a product goes in bin 1 if its size <= *x*; else the product goes in bin 2 (size > *x*). Manually adjust the split point(s) so that the values are nearly uniform across all the bins. Stop when each size bin is less than 0.3, or when there is a bin with a small number of products (too few to evaluate statistics).

A summary of the evaluated data for all display cases is shown in the table below. Refer to the supporting documentation for data evaluations of each display case. [[13]](#footnote-13)

Summary of Cases from DOE

| **Equipment Class Designation** | **No. of Units** | **% of Units Meet or Exceed 2017 Code** | **Overall % DEC < 2017 Code1** | **Min TDA (ft2) or V (ft3)** | **Max TDA (ft2) or V (ft3)** | **Split Point(s)** |
| --- | --- | --- | --- | --- | --- | --- |
| VOP.RC.M | 3,806 | 95% | 16% | 6 ft2 | 125 ft2 | 30 ft2 |
| SVO.RC.M | 3,703 | 94% | 12% | 3 ft2 | 279 ft2 | 25, 75 ft2 |
| HZO.RC.L | 219 | 100% | 10% | 10 ft2 | 90 ft2 | 35 ft2 |
| VCT.RC.M | 3,674 | 98% | 21% | 2 ft² | 161 ft² | 15, 50 ft² |
| VCT.RC.L\* | 648 | 100% | 7% | 3 ft2 | 161 ft2 | 45 ft2 |
| HCT.SC.L | 130 | 98% | 18% | 3 ft3 | 43 ft3 | 20 ft3 |
| HCS.SC.M | 246 | 85% | 23% | 2 ft3 | 31 ft3 | n/a |
| HCT.SC.I | 219 | 99% | 22% | 2 ft2 | 21 ft2 | 10 ft2 |
| VCS.SC.M | 2,525 | 96% | 23% | 1 ft3 | 121 ft3 | 30 ft3 |
| HCS.SC.L | 92 | 98% | 17% | 0.3 ft3 | 27 ft3 | n/a |
| VCS.SC.L | 971 | 98% | 15% | 1.4 ft3 | 230 ft3 | 30 ft3 |
| HCT.SC.M | 36 | 97% | 25% | 1.6 ft3 | 50 ft3 | n/a |
| VCT.SC.M | 3,223 | 97% | 14% | 0.4 ft3 | 252 ft3 | 15 ft3 |
| VCT.SC.L | 690 | 98% | 14% | 0.9 ft3 | 310 ft3 | 15, 75 ft3 |
| SOC.RC.M | 1,416 | 93% | 20% | 4 ft3 | 91 ft3 | 50 ft3 |
| SOC.SC.M | 579 | 98% | 22% | 2 ft3 | 55 ft3 | n/a |
| SVO.SC.M | 1,343 | 100% | 15% | 3 ft3 | 115 ft3 | 50 ft3 |
| VOP.SC.M | 1,036 | 100% | 13% | 3 ft3 | 67 ft3 | n/a |

Continuing with the VOP.RC.M example, for normal replacement and new construction installations, the energy savings with TDA under the split point of 30 ft2 are demonstrated in the following.

The average TDA of 22 ft2 was calculated by filtering TDA entries between the split point of 30 ft2 and the minimum TDA of 6 ft2, then computing the mean for each.

Considering the overall percentage improvement of 16% for the VOP.RC.M equipment class, the electrical energy savings (EES1) was calculated based on the 2017 federal code equation as:

*EES1 = (0.64 x TDA + 4.07) x 16% x (365 days/yr)*

The hourly energy usage for these cases is not available. Therefore, the average case kW was used to conservatively represent the DEER peak period of 4 – 9 PM peak kW savings. The electric peak demand reduction (DR1) was conservatively estimated as:

*DR1 = EES1 /(8,760 hr/yr)*

Since the federal code baseline of maximum daily energy consumption (MDEC) only depends on the total display area (TDA) or volume (V) and independent of climate zone, the UES will be the same for all climate zones and building types of the same display case class.

Peak Electric Demand Reduction (kW)

The methodology to derive peak demand reduction follows the same methodology in the Electric Savings section.

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 RUL is only applicable to the first baseline period for a retrofit measure with an applicable code baseline.

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.”[[14]](#footnote-14) This approach provides a reasonable RUL estimate without requiring any a priori knowledge about the age of the equipment being replaced.[[15]](#footnote-15)

The EUL and RUL for this measure are specified below.

Effective Useful Life and Remaining Useful Life

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| EUL (yrs)  EUL ID – *GrocDisp-FixtDoors* | 12.0 | California Public Utilities Commission (CPUC). 2014. “DEER2014-EUL-table-update\_2014-02-05.xlsx.” |

Base Case Material Cost ($/unit)

The base case material costs were estimated based on U.S. Department of Energy (DOE) Rulemaking Technical Support Document (TSD).[[16]](#footnote-16) The TSD included engineering analysis to develop the relationship between manufacturer selling price (MSP) and energy consumption for the examined commercial refrigeration equipment.

DOE developed estimates of the manufacturer production cost (MPC) based on two sets of costs. The first set is the cost to manufacture the core case, which consists of components such as structural members, shelving, wiring, air curtain grilles, etc., that do not change at higher design option levels. The second set is the cost to manufacture and install the components that make up each design option. The design option elements include heat exchangers, fans, glass doors and lighting that directly affect the daily energy consumption. After the MPC was estimated, DOE applied manufacturer markups and outbound freight cost to the MPC to estimate the MSP.

In summary, the DOE cost model is developed from the following sources:

* The core case costs are developed based on assumptions about the sourcing of parts and in-house fabrication from industry experience, information from trade publications, and discussions with manufacturers.
* The design option costs are estimated through a combination of manufacturer estimates, wholesalers’ prices, list prices, and other sources.
* DOE developed the manufacturer markup by examining several major commercial refrigeration equipment manufacturers’ gross margin information from annual reports and Securities and Exchange Commission (SEC) 10-K reports.

The DOE results are presented in analytically derived curves showing the cost-efficiency relationship for different design options. Refer to Section 5.7 of the TSD for the cost-efficiency curve and design option levels evaluated for different display case classes. Each cost-efficiency curve is defined for a unit of a representative size.

To determine a cost based on the DOE cost-efficiency curves, several steps are required.

* First, determine the representative size for the DOE analytic cost model for the equipment class. For the VOP.RC.M class, DOE defines it as 53.3 ft2.
* Next, input that representative size into the MDEC formula. The formula per 2017 Title 10 defines the current code baseline point. For the VOP.RC.M class, this evaluates to 38.18 kWh/day. The formula per 2012 Title 10 evaluates to 47.78 kWh/day for this class.
* From the baseline, apply the measure savings fraction to determine the measure DEC. For the VOP.RC.M class, the 16% savings results in 32.07 kWh/day.
* Next, identify the closest matching points on the cost-efficiency curve, and interpolate based on DEC to obtain the MSP. For the VOP.RC.M examples above: the 2012 Title 10 standard level falls between AD4 and AD5, and the estimated cost for the representative size unit is interpolated as $5,718.17. The 2017 Title 10 standard level falls between AD5 and AD6, and the estimated cost of the representative size unit is $6,980.57. The measure DEC level falls below that of the max tech level, AD9, and the estimated cost of the representative size unit is the same as the AD9 cost level, $10,324.07.
* Next, scale the cost from the representative size unit to the mean size defined for the measure code. For VOP.RC.M units up to 30 ft2, the mean size is 22 ft2, and the above costs for the representative size unit are scaled by a factor of (53.3 ft2/21.96 ft2) = 2.43.
* Finally, the scaled costs were escalated from 2019 to 2020 using the 2020 RS Means City Cost Indexes (CCI).[[17]](#footnote-17)

Measure Case Material Cost ($/unit)

The measure case material cost is estimated using the same method as the base case cost.

Base Case Labor Cost ($/unit)

The base case labor cost is estimated using the same method as the measure case labor.

Measure Case Labor Cost ($/unit)

The measure case labor costs were estimated based on RS Means 2020 labor rate equivalents for the labor and subcontractors descriptions adopted from 2010-2012 WO017 Ex Ante Measure Cost Study Final Report[[18]](#footnote-18) prepared by Itron, Inc. Labor hours were also adopted from the W0017 Cost Study.

The labor cost to install a remote condensing display case based upon the cost to install a similar display case (*Measure 4: Replace Open Medium-Temperature Display Cases with New Cases with Reach-In Doors,* Appendix C of WO017) detailed the specific labor and subcontractor description.

The total labor cost to replace a 124-ft length case includes the costs of pumping down the system, removing old cases and resetting new ones, changing suction risers, and charging and restarting the system. These labor descriptions were translated to 2020 RS Means labor rate equivalent trades as follows[[19]](#footnote-19):

* Foreman Average, Inside
* Electrician
* Plumber
* Steamfitter

To apply these labor costs to the measures, the following adjustments were made:

* The total cost per unit length of the 124-ft case was estimated as the sum product of the 2020 RS Means equivalent labor rates and the adopted labor hours from the W0017 Cost Study.
* The cost per unit length for the 124-ft length case was scaled linearly to assume a 6-ft length case.
* To adjust the labor rate from 2019 dollars, an adjustment (inflation) factor that represents the ratio of labor costs from RSMeans 2019 to RSMeans 2020 was applied to labor costs estimate. The inflation factor was calculated to be 0.9%.

Based on a manufacture survey,[[20]](#footnote-20) there is no cost for installing a self‐contained display case, assuming the building has the appropriate electric circuit.

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 new 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** | **NTG** | **Source** |
| ID: Com-Default>2yrs  ID: Agric-Default>2yrs  ID: Ind-Default>2yrs | 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 Rates

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| GSIA ID: Def-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 DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based. The 2017 Federal Code standard shown in Section 1.4.2 of this work paper is developed by analytical model to simulate the performance of each display case class. The energy consumption model is explained in the DOE rule making document. In summary, the DOE energy model evaluates the following energy consumptions: case component; compressor; and heat loads by radiation, conduction, and infiltration. The energy conservation standards take the form of linear equations expressed as a function of the refrigerated volume or total display area (TDA); hence, DEER methodology is not used for this work paper.

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 | The savings analysis is based on 2017 Federal Code standard, which is already expressed as daily energy consumption per case TDA or volume. |
| DEER Measure IDs Used | N/A |
| NTG | Source: DEER. The value of 0.60 is associated with NTGR IDs: *Com-Default>2yrs, Ind-Default>2yrs, Agric-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 | 03/31/2018 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  SCE17RN028 Revision 0 (August 11, 2016)  PGECOREF104 Revision 6 (March 30, 2016)  PGECOREF104 Revision 5 (May 20, 2014)  PGECOREF104 Revision 4 (May 11, 2012)  Consensus reached among Cal TF members. |
|  | 04/30/2019 | Akhilesh Endurthy Solaris-Technical | Consolidated SCE workpaper (SCE17RN028.0) and PG&E Workpaper (PGECOFST123)  Update calculating using latest DOE database  DEER2020 updates for Measure Application Type  Update the labor cost using inflation factor on WO017 costs |
|  | 02/27/2019 | Jennifer Holmes  Cal TF Staff | Revisions for submittal of version 01. |
|  | 11/18/2020 | Rich Williams  TRC | Updated calculation using latest DOE database  Updated labor cost using RS Means 2020.  Removed measure SWCR014P and added measures SWCR014AE, SWCR014AF, SWCR014AG, SWCR014AH, SWCR014AI, SWCR014AJ.  Clarified measure selection methodology |

1. 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. Table 3.2.5. [↑](#footnote-ref-1)
2. Navigant Consulting, Inc. 2009. *Energy Savings Potential and R&D Opportunities for Commercial Refrigeration*. Report prepared for U.S. Department of Energy. [↑](#footnote-ref-2)
3. 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. Section 5.7. [↑](#footnote-ref-3)
4. Code of Federal Regulations at 10 CFR Part 431 Subpart C. [↑](#footnote-ref-4)
5. Code of Federal Regulations at 10 CFR Part 431 Subpart C. [↑](#footnote-ref-5)
6. Total display area (ft2) of the display case (ft2) [↑](#footnote-ref-6)
7. Chilled or frozen compartment volume (ft3) [↑](#footnote-ref-7)
8. <https://www.regulations.doe.gov/certification-data> [↑](#footnote-ref-8)
9. [https://www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers](https://www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/). [↑](#footnote-ref-9)
10. Southern California Edison. 2016. "Manufacturer Survey on Commercial Display Cases." [↑](#footnote-ref-10)
11. Southern California Edison (SCE). 2020. "SWCR014-02 High Efficiency Display Case - calcs.xlsx" Database 1 DOE Refrig Single tab. [↑](#footnote-ref-11)
12. <https://www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial__Single_Compartment.html#q=Product_Group_s%3A%22Refrigeration%20Equipment%20-%20Commercial%2C%20Single%20Compartment%22> [↑](#footnote-ref-12)
13. Southern California Edison (SCE). 2020. "SWCR014-02 High Efficiency Display Case - calcs.xlsx" [↑](#footnote-ref-13)
14. California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 32. [↑](#footnote-ref-14)
15. KEMA, Inc. 2008. "Summary of EUL-RUL Analysis for the April 2008 Update to DEER." Memorandum submitted to Itron, Inc. [↑](#footnote-ref-15)
16. 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. [↑](#footnote-ref-16)
17. Southern California Edison (SCE). 2020. "SWCR014-02 High Efficiency Display Case - calcs.xlsx" [↑](#footnote-ref-17)
18. Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report.* Prepared for the California Public Utilities Commission. [↑](#footnote-ref-18)
19. RSMeans Labor Rates, 2020. https://www.rsmeansonline.com/References/LABORRATE/2-Year%202020%20Labor%20Rates/Open%20Shop%20Labor%20Rates.PDF [↑](#footnote-ref-19)
20. Southern California Edison. 2016. "Manufacturer Survey on Commercial Display Cases." [↑](#footnote-ref-20)