**Work Paper PGECOREF101**

**Night Covers for Display Cases**

**Revision # 4**

**Pacific Gas & Electric Company**

**Customer Energy Solutions Department**

**Night Covers for Open Vertical and Horizontal Display Cases (Low and Medium Temperature Cases)**

**Measure Codes R1, R74, HA66**

**PGECOREF101 R4 Night Covers**

PG&E is using the SCE work paper Work Paper SCE13RN005 ex-ante values for PG&E measure codes R1, R74 and HA66. The ex-ante values are located in file name: SCE13RN0051 – Night Covers for Vertical and Horizontal LT and MT Display Cases.xlsm

The measure mapping is as follows:

PG&E Measure code R1 = SCE code RF-45862

PG&E Measure code R74 = SCE code RF-25748

PG&E Measure code HA66 = SCE code RF-96857

**Work Paper Approvals**

The following Managers approved this work paper through the PG&E Electronic Data Routing System under Routing Requisition # 2014-59238

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| --- |
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**Work Paper SCE13RN005**

**Revision 1**

**Southern California Edison Company**

**Night Covers for Open**

**Vertical and Horizontal**

**Display Cases (Low and**

**Medium Temperature Cases)**

# At-a-Glance Summary

|  |  |
| --- | --- |
| ****Applicable Measure Codes:**** | PG&E Measure code R1 = SCE code RF-45862  PG&E Measure code R74 = SCE code RF-25748  PG&E Measure code HA66 = SCE code RF-96857 |
| **Measure Description:** | Installation of night covers on existing low temperature open vertical (or multi-deck) and horizontal (or coffin type) cases, as well as medium temperature open vertical display cases |
| **Base Case Description:** | Low temperature open vertical (or multi-deck) and horizontal (or coffin type) cases, as well as medium temperature open vertical display cases with no night cover |
| **Energy Impact Common Units:** | per (linear) ft. |
| **Energy Savings :** | Refer to Excel Calculation Attachment |
| **Gross Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Measure Incremental Cost ($/unit):** | Refer to Excel Calculation Attachment |
| **Effective Useful Life (years):** | Source: DEER 2014-EUL-table-update-2014-02-05  5 years |
| **Measure Application Type:** | Retrofit Add-on |
| **Net-to-Gross Ratios:** | Source: DEER2011\_NTGR\_2012-05-16.xls  0.6 or 0.85 depending of difficulty of installation |
| **Important Comments:** | This work paper document does not contain a data set in conformance with the 4/1/14 CPUC Ex Ante Database Specification; SCE will provide that data set separately.  Major changes for Revision 1 include: updated the work paper based on DEER 2014 code update, updated eQuest prototype from MASControl version 3.00.20. Also, updated the eQuest model weather files per DEER2014 CZ2010 weather data files and used READI tool version 2.0.1 for 2013-2014 cycle. |

# Document Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Workpaper and Revision # | Tech. Revision | MM/DD/YY | Author/Affiliation | Summary of Changes |
| SCE13RN005  Revision 0 | No | 05/04/2012 | Yin Yin Wu/BASE Energy, Inc.  Christopher Fernandez /BASE Energy, Inc. | This is the original work paper for the bridge cycle 2013-2014 |
| SCE13RN005  Revision 1 | No | 6/23/2014 | Yin Yin Wu/BASE Energy, Inc. | -Updated the work paper based on DEER 2014 code update  -Used the updated eQuest prototype from MASControl version 3.00.20  -Updated the eQuest model weather files per DEER2014 CZ2010 weather data files  -Used READI tool version 2.0.1 for 2013-2014 cycle |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

This work paper discusses the retrofit add-on installation of night covers on existing low temperature open vertical (or multi-deck) and horizontal (or coffin type) display cases, as well as medium temperature open vertical display cases. The base case for this measure is for display cases that do not use night covers. Table 1 below summarizes the measures evaluated for this work paper.

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| RF-45862 | Low Temperature Open Horizontal Night Cover |
| RF-96857 | Low Temperature Open Vertical Night Cover |
| RF-25748 | Medium Temperature Open Vertical Night Cover |

This measure applies to non-residential buildings that utilize a low temperature open vertical (or multi-deck) and horizontal (or coffin type), and medium temperature open vertical display case for food products. The space where display cases are located should have space cooling and heating. The night covers should be applied for a minimum of six hours per day. This measure should be implemented with a film type cover with small perforated holes to decrease moister build-up.

The rebates for these measures are a part of the Express program. To qualify for the incentive, the following requirements must be met:

* The night cover must be installed on an otherwise open display case to decrease cooling load of the refrigerated case during off hours.
* The display case temperature set point is between 4 and 24 degrees Fahrenheit for low-temp cases, and between 24 and 38 degrees Fahrenheit for medium-temp cases.
* The linear footage of the installed night cover must be properly measured as the incentive is based on the linear footage of the installed night cover.
* The night cover must be applied for an average period of at least 6 hours per day.
* The display cases which have the installed night covers must have the following:
  + Compressor capacity modulation mechanisms (such as variable-speed drive (VSD) or cylinder unloader).
  + Evaporator pressure regulators (EPR) set to higher suction temperatures when night covers are applied.
  + Resized TXVs set with higher suction pressures when covers are applied.
  + Applications must include information regarding modifications to or proof of existing refrigeration capacity modulation controls.
* The night covers must be installed by an authorized product representative where the installer can verify that the night covers are compatible with the display cases so that they do not degrade system performance.

**Pacific Gas and Electric requirements:**

* Installation address must have a commercial electric account with PG&E.
* Must install a cover on an existing open refrigerated display case to decrease cooling load of the refrigerated case during off hours.
* Case manufacturer must not object to the use of night covers.
* Rebate is based on linear footage of the installed night cover.
* Customer should consider using proper compressor capacity modulation mechanisms [such as Variable Speed Drive (VSD) or cylinder un-loader], Evaporator Pressure Regulators (EPR) and possibly resetting to higher suction temperatures when covers are applied.
* The cover must be applied for a period of at least six hours.
* This measure should be implemented with a film type cover with small perforated holes to decrease moister build-up.

## 1.2 Technical Description

This work paper discusses the retrofit add-on installation of night covers on existing low temperature open vertical (or multi-deck) and horizontal (or coffin type) display cases, as well as medium temperature open vertical display cases. It is recommended that these covers be a film type cover with small perforated holes to decrease moisture build-up and must be applied for a period of at least six hours. These types of display cases can be found in small- and medium-to-large size grocery stores. 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 air temperature inside medium and low temperature display cases can range from +10 to +35°F and -25 to -15°F, respectively [A]. Since the majority of the losses are due to infiltration this work paper only considers infiltration.

## 1.3 Measure Application Type

This work paper addresses retrofit add-on installations of the night covers. The delivery methods are: Financial Support - Down Stream Incentive – Deemed, Financial Support – On-bill Finance – loan, Financial Support – Direct Install.

## 1.4 Measure and Base Case Cost Effectiveness Data

### 1.4.1 DEER Measure and Base Case Analysis

Measure ID D03-205 in the 2014 Database for Energy Efficient Resources (DEER) READI tool, which addresses installing night covers on medium-temperature open display cases.It does not address installing night covers on low-temperature open display cases (vertical or horizontal). The DEER 2014 savings are based on applying covers for a period of four hours and the database does not distinguish between vertical and horizontal cases. Also, the measure characteristics presents the savings due to installing infiltration barrier as 50%, this compares favorably with other studies on horizontal display cases and thus it is assumed that the database is referring to horizontal cases only. For medium-temperature display cases, existing DEER 2014 values are used.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | Deer does not include installing night covers on low-temperature open display cases (vertical or horizontal). |
| DEER Version | DEER 2014, DEER 05 |
| DEER Run ID and Measure Name (Sample) | D03-205 – Medium Temperature |

**Net to Gross**

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 5 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [351]. The relevant NTGR for this measure is shown in Table 3 below.

Table 3 Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | NTG\* |
| Com-Default>2yr | All other EEMs with no evaluated NTGR; existing EEM in programs with same delivery mechanism for more than 2 years | Com | Any | All | 0.6 |
| Com-Default-HTG-di | All other EEM with no evaluated NTGR; direct install to hard-to-reach only. | Com | Any | DirInstall | 0.85 |

\*Denotes that the column is taken from the DEER NTG Table.

**Installation Rate**

The installation rate (IR) is identified in the calculation attachment. This value is obtained from the support table available in READi. Currently there is no versioning on the installation rate table. To address appropriate selection of the installation rate the date of the workpaper will serve as the last date checked for updated IR values. The installation rate varies by end use, sector, technology, application, and delivery method. The relevant IR values for this measure are shown in Table 4.

Table 4 Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | GSIAValue\* |
| Def-GSIA | Default GSIA values | Any | Any | Any | 1 |

**Spillage Rate**

Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

**READi Technology Fields**

To support the development of the ED ex ante tables, select fields from the ex ante database will be identified in the workpaper. For a full set of values associated with the measures in the workpaper refer the Excel calculation template.

Table 5 READi Tech IDs

|  |  |
| --- | --- |
| READi Field Name | Values included in this workpaper |
| Measue Case UseCategory | Commercial Refrigeration |
| Measure Case UseSubCats | Refrigeration Display |
| Measure Case TechGroups | Grocery Refrigeration System |
| Measure Case TechTypes | Horizontal (coffin) Display Fixture |
| Base Case TechGroups | Grocery Refrigeration System |
| Base Case TechTypes | Horizontal (coffin) Display Fixture |

### 1.4.2 Codes and Standards Analysis

This measure is not governed by either State, such as Title 24 (2013) [355] and Title 20 (2014) [C], or Federal codes and standards.

Table 6 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| N/A | N/A | N/A |

### 1.4.3 Non-DEER Study Review

All of the data used or reviewed in the preparation of this workpaper comes from DEER Database.

### 1.4.4 Measure and Base Case Effective Useful Life

DEER14 update documentation provides EUL and RUL information to be used for the 2015 program cycle extension on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “Summary of EUL-RUL Analysis for the April 2008 Update to DEER” provides the RUL value as a flat 1/3 of the EUL value. The RUL value will only be applied to the first baseline period for retrofit measures that have applicable code that will affect the energy savings. In all other installation types and retrofit with no applicable code that affects the energy savings, the RUL is not applicable to either the first or second baseline period.

To obtain the EUL value the DEER14 update documentation, DEER2014-EUL-table-update-2014-02-05.xls [213], was consulted.

Table 7 below identifies the value/methodology used for the measures in this work paper.

Table 7 DEER14 EUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| READi EUL ID | Market | Enduse | Measure | EUL (Years) | RUL (Years) |
| GrocDisp-DispCvrs | Non-Residential | Refrigeration | Night Covers for vertical and horizontal refrigerated display cases | 5 | N/A |

# Section 2. Energy Savings & Demand Reduction Calculations

Table 8 contains the data files for measures that are taken directly from the DEER 2014 READI Tool version 2.0.1 or were created using the READI Tool. These results have not been modified and are only being included in the workpaper for reference.

Table 8 READi Tool Outputs

|  |  |  |
| --- | --- | --- |
| Solution Code | Measure Name | READi Results |
| RF-25748 | Medium Temperature Open Vertical Night Cover | Attachment B |

The following assumptions were made for the calculations of this work paper:

* The building simulation models were generated for a Grocery Store with multiplex-compressor systems for the refrigeration display cases. Single-compressor systems are less efficient than multiplex-compressor systems. According to the DEER Report [26], single-compressor systems were typically designed prior to 1980. To be conservative, it is assumed that the generated energy savings of this work paper will also be applied to display cases with single-compressor systems.
* This work paper is applied to display cases located inside a space which has space heating and space cooling. The unit energy savings is represented per linear-foot of the display case. The resulted savings involve savings of refrigeration load reduction and space heating load reduction. Note that there is also a slight increase to the space cooling energy consumption. 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 resulted savings of Grocery Store is applied to all other building types considered in this work paper with building vintage weights.

The energy savings and demand reduction for this work paper is based on applying night covers on the following display case types: low temperature open horizontal, low temperature open vertical and medium temperature open vertical. The display cases are applicable to, but not limited to, grocery stores. According to the DEER Report [26], the majority of heat gain of an open display fixture is via infiltration. Covering open fixtures during hours the store is closed can reduce convection by 50% or more during this time, resulting in refrigeration load reductions.

The Medium Temperature Open Vertical Night Cover measure of this work paper is addressed in both the 2014 DEER READI Tool and the 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study final Report of measure ID D03-205. Please refer to the DEER Report Section 6 for details of DEER Building Prototypes generated by eQuest (a graphical interface to DOE-2.2), Section 7.3 for general description for grocery refrigeration measures, and Page 7-74 for detail descriptions of this measure. The unit energy savings of this measure is obtained from READI, a DEER2014 Database Tool. The DEER measure ID D03-205 assumes constant infiltration for all hours as the base case, and the measure case applies a multiplier of 0.50 to the infiltration for night cover application. The energy savings reported in DEER 2014 are given per climate zone and per vintage for grocery store buildings. The savings for medium temperature night covers is taken from the DEER READI Tool for 2014 vintage (which is a conservative assumption). The finals savings can be found in Attachment A.

The measures are weather sensitive and the building energy simulation tool eQuest V3.65 was used to determine the annual impacts. The built-in, Code 2013 DEER building prototypes of grocery store, generated by MASControl version 3.00.20, were used for simulations of the other two measures: Low Temperature Open Horizontal Night Cover and Low Temperature Open Vertical Night Cover. The DEER building prototypes consider multiplex-compressor systems as the refrigeration type. Using the same methodology as the DEER measure ID D03-205, the simulation modes assume constant infiltration for all hours as the base case, and the measure case applies a multiplier of 0.50 to the infiltration for 6 hours per day between mid-night to 6 A.M. with night covers applications on the low temperature open horizontal and vertical display cases.

The DEER building prototypes have built-in refrigeration fixtures for low temperature open horizontal display cases. These fixture models were used for the Low Temperature Open Horizontal Night Cover measure simulations. Since no built-in refrigeration fixtures are available for low temperature open vertical display cases, a low temperature open vertical display case was added in the DEER building prototypes for the Low Temperature Open Vertical Night Cover measure simulations. Components of the low temperature open vertical display case model are included in Table 9 .

Table 9 Summary of Modeled Low Temperature Open Vertical Display Case

|  |  |
| --- | --- |
| **Component** | **Values** |
| Evaporator Fan Power | 0.0251 (kW/ft) \* |
| Lighting Power | 0.0199 (kW/ft) \* |
| Defrost | 2,474 (Btu/hr-ft) |
| Anti-Sweat Power | 0.05 (kW/ft) |
| Infiltration Load | 1303.5 (Btu/hr-ft) |
| Conduction Load | 248.8 (Btu/hr-ft)\* |
| Total Refrigeration Load | 1918.9 (Btu/hr-ft) \* |
| Saturated Evaporator Temperature | -16.9 (°F) \* |
| Line-Up Length | 24 (ft) |

Source: DOE 2009a, Appendix D [B]

\* Average value of all efficiency levels considered for low temperature open vertical display cases.

Once the base case and measure case model simulations were completed, the energy demand savings could be determined. Comparing the total energy consumption (electricity and natural gas) of both models, the total energy savings were determined. The unit energy savings, in kWh/yr-ft2 for electricity and therm/yr-ft2 for natural gas, were calculated by dividing the total energy consumptions by the total line-up length of the display cases. Refer to Attachment [C] for summary of savings outputs.

Since the night covers will be applied during hours the store is closed, which are in the night time, implementing this measure will not impact the energy demand during peak period. Thus, it will not result in any demand reduction.

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the Refrigeration load shape. See **Error! Reference source not found.** for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 10 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Assembly | Assembly | Refrigeration |
| Grocery | Grocery\_Store | Refrigeration |
| Food Store | Food\_Store | Refrigeration |
| Restaurant - Fast-Food | Fast\_Food\_Restaurant | Refrigeration |
| Restaurant - Sit-Down | Sit\_Down\_Restaurant | Refrigeration |
| Retail - Multistory Large | Retail - Multistory Large | Refrigeration |
| Retail - Single-Story Large | Retail - Single-Story Large | Refrigeration |
| Retail - Small | Retail - Small | Refrigeration |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

As these measures are Retrofit – Add-Ons, the base case assumes the refrigerated display cases are not equipped with night covers. According to 2014 DEER Measure ID D03-205, there is no cost ($0.00 per unit) associated with the base case [215].

## 4.2 Measure Case Cost

According to the DEER 2014 cost documentation [215], the material and labor costs for both medium and low temperature night covers for open horizontal and vertical refrigerated display cases is $37.63 and $4.57 per linear foot of night cover, respectively.

## 4.3 Gross and Incremental Measure Cost

### 4.3.1 Gross Measure Cost

For the Ret – Add-On measure category, the gross measure cost is the measure material cost ($37.63) plus the measure labor cost ($4.57), which is $42.20 per linear foot of night cover.

### 4.3.2 Incremental Measure Cost

According to 2014 DEER Measure ID D03-205, the incremental equipment cost is $37.63 per linear foot of night cover and labor cost of $4.57 per linear foot of night cover. [215]

[Equation 1] ∆cost/unit:

For Ret – Add-On measures, the IMC (∆cost/unit) is defined as the difference in costs between the base case and the measure equipment. Installation labor costs are assumed to be the same.

X = Base Case Cost = $0

Y = Measure Equipment Cost = $42.20

∆cost/unit = Y- X = $42.20

# Attachments

The attachment files are saved separately and not embedded in the Word document.

[Attachment-A]

Calculation Template 2015 v3\_SCE13RN005.xlsm

[Attachment-B]

READi-EnergyImpacts\_D03-205\_SCE13RN005

[Attachment-C]

SCE13RN005 - Savings Summary

[Attachment-D]

SCE13RN005 – eQuest Models

# References

The Reference file has been saving separately and not embedded in the Word Document.

[26]

[31]

[132]

[213]

[215]

[355]

[A] ASHRAE 2006. Refrigeration Handbook. Atlanta, Georgia. pp. 46.2, Table 1.

[B] DOE 2009a. Energy Conservation Standards for Commercial Refrigeration Equipment:

Technical Support Document, U.S. Department of Energy, January 2009.

<http://apps1.eere.energy.gov/buildings/publications/pdfs/corporate/commercial_refrig_report_10-09.pdf>

APPENDIX D. ANNUAL ENERGY SIMULATION INPUTS AND RESULTS FOR COMMERCIAL REFRIGERATION EQUIPMENT: <http://www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/cre_tsd_appendixd.pdf>

[C] 2014 Appliance Efficiency Regulations (Title 20), CEC-400-2014-019-CMF (2014).

# Appendix A – SCE/ED Application Types

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| SCE Program Type | ED Application Type | 1st Baseline Savings | 2nd Baseline Savings | 1st Baseline Cost | 2nd Baseline Cost | 1st Baseline Life | 2nd Baseline Life |
| New | New Construction (Nc) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Replace on Burnout (ROB) | Replace on Burnout (Rob)/Normal Replacement (NR) | Above Code/Standard | N/A | Incremental Cost | N/A | EUL | 0 |
| Retrofit (RET) | Early Replacement (ER) | Above Cust. Existing | Above Code/Standard | Full Cost | Incremental Cost | RUL | EUL-RUL |
| Retrofit – First Baseline Only (REF) | Early Replacement RUL (ErRul) | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |
| Retrofit Add-on (REA) | N/A | Above Cust. Existing | N/A | Full Cost | N/A | EUL | 0 |