**Work Paper SCE13RN009**

**Revision 1**

**Southern California Edison Company**

**Anti-Sweat Heater (ASH) Controls**

# At-a-Glance Summary

|  |  |
| --- | --- |
| ****Applicable Measure Codes:**** | RF-12098  RF-48112 |
| **Measure Description:** | Anti-Sweat Heater (ASH) controls based on humidity for reach-in display freezers and coolers |
| **Base Case Description:** | Fixed ASH operation for reach-in display freezers and coolers |
| **Energy Impact Common Units:** | Energy impacts are shown per linear foot (width) of display cases |
| **Energy Savings :** | Refer to Excel Calculation Attachment |
| **Gross Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit):** | Refer to Excel Calculation Attachment |
| **Effective Useful Life (years):** | Source: DEER2014-EUL-table-update\_2014-02-05.xls  12 years |
| **Measure Application Type:** | Retrofit Add-on (REA) |
| **Net-to-Gross Ratios:** | Source: DEER2011\_NTGR\_2012-05-16.xls  0.6, 0.85 |
| **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 results based on the new weather files (CZ2010) developed for the 2013 Title 24; eQuest models were developed based on the DEER 2014 (DEER14) prototype models as extracted from MASControl V3.00.20; Peak demand savings was updated based on the DEER14 peak demand period definition. |

# Document Revision History

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Workpaper and Revision # | Tech. Revision | MM/DD/YY | Author/Affiliation | Summary of Changes |
| SCE13RN009.0 | No | 05/18/2012 | Yin Yin Wu/BASE Energy, Inc.  Chris Fernandez/BASE Energy, Inc. | This is the original work paper for the bridge cycle 2013-2014. |
| SCE13RN009.1 | Yes | 7/7/2014 | Yin Yin Wu/ BASE Energy, Inc.  Steven Wiryadinata/BASE Energy, Inc. | * Simulation models updated using DEER14 prototype models from MASControl v3.00.20 * Updated savings results based on the CZ2010 weather files * Peak demand savings was updated based on the DEER14 peak demand period definition * Work paper updated for reporting period, effective 07/01/14-12/31/14 |

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

The objective of this work paper is to detail the energy savings for installing anti-sweat heater (ASH) controls based on humidity for reach-in display freezers and coolers.

The base and measure cases are summarized as follows (Section 1.2 describes these cases in greater technical detail):

**Base Case**: Fixed ASH operation (no control) for reach-in display freezers and coolers.

**Measure Case**: ASH controls based on humidity for reach-in display freezers and coolers.

As shown in Table 1, measures evaluated in this work paper are segregated based on refrigeration operating temperature: low temperature (freezer) and medium temperature (cooler).

Table 1 Measure Names

|  |  |
| --- | --- |
| Solution Code | Measure name |
| RF-12098 | Low Temperature Display Case Anti-Sweat Heater (ASH) Controls |
| RF-48112 | Medium Temperature Display Case Anti-Sweat Heater (ASH) Controls |

**Eligibility**

The above-described measures are eligible for installations on existing reach-in display coolers and freezers according to the descriptions shown in **Base Cases** in Section 1.2 and is applicable for any commercial retail facility, including (but not limited to) supermarkets, grocery stores, hotels, restaurants and convenience stores. Proposed ASH controls must adjust the ASH duty cycle based on humidity of air on the glass surfaces of the display cases. This measure cannot be used in conjunction with the New Refrigeration Display Case with Doors measure. Energy savings credit for reduced use of display refrigerator anti-sweat heaters can only be taken if the display refrigerators are equipped with humidity-sensing controls that reduce the amount of power supplied to the heaters as the store dew point temperature decreases.

**Express Requirements**

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

* The proposed device must sense the relative humidity in the air outside of the display case and reduce or turn off the glass door (if applicable) and frame anti-sweat heaters at low humidity conditions. Equivalent technologies that can reduce or turn off anti-sweat heater based on the amount of condensation formed on the inner glass pane may also qualify. Power reduction should occur when relative humidity levels reach 55% and lower. Power reduction should decrease by at least 2% for every percentage the humidity falls below 55%.
* This can be the only Express Solution category under which the fixtures are receiving incentives. This solution cannot be used in conjunction with New High-Efficiency Refrigeration Display Cases with Special Doors (Low Temp) and Special Doors with Low/no Anti-Sweat heat on Low Temperature Display Cases categories.
* 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.

**Pacific Gas and Electric**

Requirements:

* Installation address must have a commercial electric account with PG&E.
* Must sense the relative humidity in the air surrounding the display case and reduce or turn off the anti-sweat heaters of the glass door (if applicable) and door frame during periods of low humidity.
* Equivalent technologies that reduce or turn off anti-sweat heaters depending on the level of condensation on the inner glass pane may qualify.
* Rebate is based on linear footage of the installed night cover.

Exclusions

* Cannot be used in conjunction with the “New Refrigeration Display Case with Doors” rebate.

## 1.2 Technical Description

This work paper focuses on ASH controls based on humidity to prevent condensation (“sweating”) on the glass surface of refrigerated display cases. ASHs are electric resistance heaters installed at the following locations:

* Case mullion to prevent condensation on metal surfaces (Figure 1 ASH **Locations** Green )
* Door frame to prevent condensation on metal surfaces (Figure 1 ASH **Locations** Red)
* Glass edge to prevent condensation on the glass (Figure 1 ASH **Locations** Blue)



**Figure 1 ASH Locations**

A grocery store’s RH is closely related to the outdoor dew point (DP) temperature. Condensation occurs when the air temperature drops to the DP temperature. On warmer days when a customer opens the refrigerated display case glass door, warm moist air comes into contact with the cold glass surface which leads to condensation on the surface of the glass door. ASHs are used to evaporate this moisture from the glass surface, door frame and mullion of the cases.

In standard installations, the ASHs operate at full power 100% of the time. ASH controllers monitor the DP temperature of ambient air and adjust the duty cycle of the heaters accordingly. For example, when the air is dry and its dew point is low, the ASHs operate at a low duty cycle and surface is allowed to get cold since condensation will not form. On the other hand, when the air is humid and dew point is high, the ASHs operate at 100% duty cycle to keep the surface warm and above the dew point temperature. Between these extremes, the duty cycle is adjusted according to the measured DP.

Some of the heat generated by ASHs ends up as a load on the refrigeration system. Therefore, any reduction in ASH power not only will reduce the ASH electric demand, but also result in lower refrigeration loads. As a result, compressor run time and energy consumption are reduced. However, there will be a penalty incurred from the increased space heating energy use.

This measure applies to ASHs on both low temperature (freezer– below 32°F) and medium temperature (cooler – above 32°F) glass doors. Calculations for both coolers and freezers were carried out for all 16 California climate zones.

## 1.3 Measure Application Type

Note: See Appendix A for a comparison of the application types used by and incorporated into SCE systems versus the application types available in the newest revision of DEER 2014. Appendix A will serve as a translation between the outputs of this workpaper and application types used by READi.

The delivery mechanisms for this measure are Financial Support-Down-Stream Deemed; Financial Support-On-bill Finance; and Financial Support-Direct Install. The install type for these delivery mechanisms is Retrofit Add-on (REA).

## 1.4 Measure and Base Case Cost Effectiveness Data

### 1.4.1 DEER Measure and Base Case Analysis

The savings presented in this workpaper were based on the DEER 2014 (DEER14) prototype building models extracted from MASControl V3.00.20 software. DEER14 was a major update to the DEER 2011 version and incorporates changes based on the new 2013 Title 24. The DEER14 database contains measures for ASH Controls on low and medium temperature refrigerated display cases (D03-230 and D03-231, respectively) which are incorporated in the prototype models. Table 2 summarizes the deviation from DEER.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | Yes |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | DEER presents savings per building vintage. Savings in this work paper are based on vintage 2014, v14. The updated eQuest prototypes from MASControl version 3.00.20 for vintage 2014 were used in this work paper. The eQuest model weather files were updated per DEER2014 CZ2010 weather data files. |
| DEER Version | DEER14 |
| DEER Run ID and Measure Name (Sample) | D03-230: Control anti-sweat heater based on humidity |

**Net to Gross**

The net-to-gross ratio (NTGR) describes the free-ridership in energy efficiency programs and quantifies a particular program’s net impact based on its gross savings. The NTG ratios were 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 NTGRs for this measure are shown in Table 3.

Table 3 Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID | NTG\* |
| Com-Default>2yrs | 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-HTR-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.

Note that for the direct install delivery mechanism, a distinction between hard to reach and non-hard to reach markets will be made on a project by project basis. This work paper shows the NTG associated with a hard to reach direct install delivery mechanism and the non-residential defaulted NTG value, where in fact, a measure offered through direct install and is not “hard to reach” will receive a default NTG value.

**Installation Rate**

The installation rate (IR) represent the ratio of the number of verified installations of the measure to the number of claimed installations rebated by the utility. 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. There are currently no IR specific for this measure and the default value of 1 has been presented 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 represents additional energy efficiency actions that participants take outside the program. Spillage rate (SR) will also be applied to measures however the values will not be tracked in the workpapers. SR 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 |
| Measure Case UseCategory | Commercial Refrigeration |
| Measure Case UseSubCats | Refrigerated Display |
| Measure Case TechGroups | Grocery Refrigeration System |
| Measure Case TechTypes | Reach-in Storage |
| Base Case TechGroups | Grocery Refrigeration System |
| Base Case TechTypes | Reach-in Storage |

### 1.4.2 Codes and Standards Analysis

This work paper deals with REA-type measures whose savings are not impacted by code standards. Discussion on the standards as they relate to the measures is summarized in Table 6 and presented here for information purposes only.

The 2014 Appliance Regulations [422] addresses Walk-in Coolers and Freezers with Transparent Reach-in Doors and specifies the limit of ASH power draw based on square footage. Section 1605.1(a)(5)(C)(2) states:

*If the appliance has an anti-sweat heater with anti-sweat heat controls, and the total door rail, glass, and frame heater power draw is more than 7.1 watts per square foot (W/ft²) of door opening (for freezers) and 3.0 watts per square foot (W/ft²) of door opening (for coolers], the anti-sweat heat controls shall reduce the energy use of the anti-sweat heater in a quantity corresponding to the relative humidity in the air outside the door or to the condensation on the inner glass pane.*

Table 6 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 20 (2014) | 2014 Appliance Efficiency Regulations, Section 1605.1(a)(5)(C)(2) | May 1, 2014 |
| Title 24 (2013) | N/A | July 1, 2014 |

### 1.4.3 Non-DEER Study Review

All data was taken from either DEER14 or Title 20 code standards.

### 1.4.4 Measure and Base Case Effective Useful Life

Effective Useful Life (EUL) represent an estimate of the median number of years that measures installed under the program are still in place and operable. Remaining Useful Life (RUL) represent an estimate of the median number of years a technology or piece of equipment being replaced or altered by an energy efficiency program would remain in service and operational had the program intervention not cause the replacement or alteration.

DEER14 update documentation provides EUL and RUL information to be used for the 2013-14 program cycle on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “DEER2014-EUL-table-update\_2014-02-05.xlsx” 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.xlsx” [436], 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-ASH | Non-Residential | Refrigeration | Anti-Sweat Heat (ASH) Controls | 12 | N/A |

# Section 2. Energy Savings & Demand Reduction Calculations

**Assumptions**

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

1. The DEER14 prototype building models were generated for a Grocery Store with multiplex-refrigeration systems for the reach-in refrigerated fixtures using the MAS Control software. 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 for this work paper will also be applied to fixtures with single-compressor systems.
2. This work paper is applied to fixtures located inside a space which has space heating and space cooling. The unit energy savings is represented per linear-foot of the fixture. The resulting savings involve refrigeration load reduction and space cooling load reduction. Note that it also results in an increase to the space heating energy consumption. Since the heat gain to a fixture mainly depends on the temperature maintained for the fixture 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 for Grocery Store is applied to all other building types considered in this work paper.

**Methodology**

The energy savings and demand reduction for this work paper is based on installing controllers on the existing anti-sweat heater (ASH) on freezers (including low temperature display cases) and coolers (including medium temperature display cases). The fixtures are applicable to, but not limited to, grocery stores. The baseline of this work paper is the ASHs operating continuously. Installing ASH control will reduce the ASH operating hours significantly, resulting in savings on the refrigeration cooling load and space cooling load.

The measures are weather sensitive and the building energy simulation tool eQuest Refrigeration 3-65 was used to determine the annual impacts. The 2004-2005 Database for Energy Efficiency Resources (DEER) Update Study final Report [26] has included the measures of Freezer ASH Controls (D03-230) and Cooler ASH Controls (D03-231). Table 8 summarizes the DEER measure IDs corresponding to each solution code. 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. The DEER measures consider multiplex-compressor systems as the refrigeration type.

Table 8 Summary of DEER Measures and Corresponding Solution Codes

|  |  |  |  |
| --- | --- | --- | --- |
| Solution Code | Measure Name | DEER05 Measure ID | DEER08 Measure ID |
| RF-12098 | Freezer ASH Controls | D03-230 | D08-NE-GrocRefg-FixtDoors-LowTemp-FxdAntiSwt-HmdAntiSwt |
| RF-48112 | Cooler ASH Controls | D03-231 | D08-NE-GrocRefg-FixtDoors-MedTemp-FxdAntiSwt-HmdAntiSwt |

The baseline of the Freezer ASH Controls (D03-230) and Cooler ASH Controls (D03-231) measures considers the anti-sweat heaters operating at fixed full power all the time. The measure models consider ASH control based on humidity. The DEER 2014 prototypes were generated from MASControl version 3.00.20 with the weather files updated using DEER2014 CZ2010 weather data files. The built-in ASH control types based on the fixture temperature are included in Table 9 below.

Table 9 Summary of Built-In ASH Control Types from DEER Prototypes

|  |  |  |
| --- | --- | --- |
| **Component** | **Freezer** | **Cooler** |
| ASH Control Type | Humidity-Ratio | Humidity-Ratio |
| Maximum Humidity | 80% | n/a |
| Minimum Humidity | 60% | n/a |
| Maximum Humidity Ratio | 0.011 | 0.011 |
| Minimum Humidity Ratio | 0.005 | 0.005 |

**Electrical and Natural Gas Energy Savings**

Once the base case and measure case model simulations were completed, the energy savings and demand reduction 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-ft for electricity and therm/yr-ftfor natural gas, were calculated by dividing the total energy savings by the total line-up length of the fixtures. Note that the built-in fixtures were modeled per number of doors. The total line-up length of each fixture is calculated based on 2.6 ft per door.

**Peak Demand Savings**

Peak demand savings were calculated by taking the average electrical power draw between 2-5 pm in the 3 consecutive peak days specified in the DEER2013 Update documentation [386] for each climate zone. Table 10 summarizes the 2014 DEER Peak-Demand periods for 16 climate zones considered in this work paper. The difference in the baseline and measure peak demands represents the peak demand savings. Similar to the energy savings, the unit demand reduction, in kW/ft, was calculated by dividing the total demand reduction by the total line-up length of the fixtures.

|  |  |
| --- | --- |
|  | **Table 10. 2014 DEER Peak-Demand Periods** |

|  |  |  |  |
| --- | --- | --- | --- |
| Climate Zone | Dates | Climate Zone | Dates |
| CZ01 | Sep 16-18 | CZ09 | Sep 1-3 |
| CZ02 | Jul 8-10 | CZ10 | Sep 1-3 |
| CZ03 | Jul 8-10 | CZ11 | Jul 8-10 |
| CZ04 | Sep 1-3 | CZ12 | Jul 8-10 |
| CZ05 | Sep 8-10 | CZ13 | Jul 8-10 |
| CZ06 | Sep 1-3 | CZ14 | Aug 26-28 |
| CZ07 | Sep 1-3 | CZ15 | Aug 25-27 |
| CZ08 | Sep 1-3 | CZ16 | Jul 8-10 |

Refer to the Attachment [B] for the savings summary for all measures in 16 CZs.

# 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 Table 11 for a list of relevant Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 11 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 | Large\_Retail\_Store | Refrigeration |
| Retail - Single-Story Large | Large\_Retail\_Store | Refrigeration |
| Retail - Small | Small\_Retail\_Store | Refrigeration |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

The base case cost is $0 since the existing ASH can continue to operate without duty cycling controls.

## 4.2 Measure Case Cost

The measure case costs were based on the “Revised DEER Measure Cost Summary (05\_30\_2008) Revised (06\_02\_2008). xls” [218] and calculated per width of display case at $37.24/ft. Cost calculation methodologies are discussed in detail in Section 4.3.

## 4.3 Gross and Incremental Measure Cost

### 4.3.1 Gross Measure Cost

Per the E3, the gross measure cost (GMC) represents the cost to purchase and install an energy efficiency measure. In the case of REA, the cost invoked is the full cost of the equipment and installation of the energy efficient equipment. GMC is represented by the equation:

GMC = Measure Equipment Cost + Measure Labor Cost

2008 DEER cost data lists equipment and labor costs for ASH controller per circuit of controlled ASHs. Based on an online survey of ASH controllers, controller capacity ranges from 16A to 30A[[1]](#footnote-1). A typical door (2.6 ft wide) with ASH draws about 1.6-amp. To be conservative, it is assumed that the electric circuit is operating at 80% of its capacity or 12.8 amps are available to control the ASHs.

* $600 material + $368.23 labor per ASH controller = $968.23 total cost per controller
* 12.8-amp per controller/1.6-amp per door x 2.6 ft per door = 20.8 linear ft. per controller
* $968.23 per controller/ 20.8 ft per controller = $46.55 per ft. of display case

From this methodology, it follows that the higher the controller capacity, the lower the cost per linear foot of door. However, since DEER does not specify the circuit capacity for the supplied price point, the lowest 16A capacity has been assumed to obtain a conservative cost.

### 4.3.2 Incremental Measure Cost

Incremental Measure Cost (IMC) is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. For REA there exists no base case to compare the measure to. Thus, IMC is equal to the GMC.

# Attachments

1. 

1. 
2. 

# References



[31][213][218][351][386][422]

# 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 |

1. <http://www.apexcontrolsinc.com/sweatmiser/manuals/SWM-Manual-MT.pdf>

   <http://www.fridgewize.com/anti-sweat-heater-controls>

   <http://www.gemtronfooddisplay.com/downloads/Technical/CoolTrolControllerInstructions.pdf>

   (accessed 7/2/14). [↑](#footnote-ref-1)