**Work Paper PGE3PREF116**

**Add Doors to Open Med Temp Cases**

**Revision 3**

**CLEAResult**

**EnergySmart Grocer**

**Add Doors to Open, Medium-Temperature Cases**

**Measure Code HA09, RF013**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | **HA09, RF013** |
| **Measure Description:** | Retrofit adding glass doors to existing medium temperature (MT) open vertical refrigerated display case. |
| **Energy Impact Common Units:** | Len-ft (length, feet)  Display case length in feet |
| **Base Case Description:** | Existing open vertical MT refrigerated display case. Case assumed to have night covers in place. |
| **Base Case Energy Consumption:** | kWh per foot of case varies across climate zones. |
| **Measure Energy Consumption:** | kWh per foot of case varies across climate zones. |
| **Energy Savings (Base Case – Measure)** | kWh per foot of case varies across climate zones. |
| **Costs Common Units:** | Per Len-ft ( length, feet)  Display case length in feet |
| **Base Case Equipment Cost ($/unit):** | $0 for Add On Equipment (AOE) |
| **Measure Equipment Cost ($/unit):** | $301.84 per Len-ft (w/o LED)  $331.12 per Len-ft (with LED) |
| **Full Measure Cost ($/unit)** | $394.17 / Len-ft  Source: Project Bids as provided by 3rd party implementer, CLEAResult |
| **Effective Useful Life (years):** | EUL: 15 years  RUL: 5 years  RefgWrhs-Cond  Source: DEER2016 |
| **Measure Application Type:** | Add On Equipment (AOE) |
| **Net-to-Gross Ratios:** | 0.60, Com-Default>2yrs  Source: DEER2016 |
| **Important Comments:** |  |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision Date** | **Description of Revisions** | **Author (Company)** |
| **Revision 0** | 06/08/2012 | Original work paper titled “Vertical Refrigerated Case, Medium Temperature: Open to Closed” with file name “WP\_PECIREF\_PGE604\_R0 110701” | James Anthony, P.E., Engineering Manager, PECI Michele Friedrich, PECI  Eric Mullendore, PECI |
| **Revision 1** | 04/28/2014 | Updated savings data according to new climate zone weather files. Formatting updated per PG&E guidelines | Brian Owens, PECI  Danielle Geers, PECI |
| **Revision 2** | 03/07/2016 | Updated to the latest ex ante format 2016. | Linda Wan, PG&E |
| **Revision 3** | 06/24/2019 | Updated measure savings from the previous version 2 by modeling the measure in the new DEER 2020 Grocery Prototype eQUEST models. The version 3 models were generated from MAS Control V3.00.19.  Cost update based on program data.  Added new measure RF013 for new doors with LED lighting.  Retired measure RA01. | Christopher Rogers, CLEAResult  Randy Kwok, PG&E |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

This measure pertains to the addition of glass doors onto existing open-vertical, medium-temperature refrigerated display cases (also known as open multideck cases). Such display cases are heavily represented in a typical supermarket and can also be found in a variety of other food retail settings such as smaller grocery stores and some large convenience stores. They can be self-contained systems with a refrigeration compressor and condenser built into the case structure, but more commonly they are served by remote compressors and condensers. In supermarkets, the remote compressors are generally arranged into combined suction groups described as a multiplex system.

The program currently only rebates adding new doors without LED lights. However; PG&E’s historical program data indicates that majority of the customers who applied for the rebate actually installed new doors with integrated LED lights. PG&E believes this reflects the program actually influenced the customer to upgrade the case lighting while adding new doors to their existing open cases. Hence it is reasonable for the program to also offer the retrofit add door with integrated LED lighting replacing the existing cases’ fluorescent lighting.

***Program Restrictions and Guidelines***

This is an Add-On Equipment (AOE) measure.

***Terms and Conditions:***

**Requirements:**

* Add new glass doors, without LED lights, to an existing open vertical, medium-temp display case.
* Add new glass doors with LED lights and existing (canopy) baseline lighting in the case must be removed. Existing cases must not have LED lights.
* Total lighting power in the case after the retrofit may not exceed total lighting power in the existing case.
* No anti-sweat heat may be present in the glass doors or door mounting.

**Exclusions:**

* This rebate applies to open vertical cases only.

**Additional Details:**

* Rebate paid based on linear feet of door installed.

***Market Applicability***

This measure is intended for grocery stores and supermarkets (GRO). It is an Add-On Equipment measure. This work paper provides energy savings that vary by climate zone and are applicable to all vintages. The recipient of the rebate is downstream. The rebate will reduce the simple payback period of the measure to a feasible level that can be implemented by the consumer. Without the rebate, the simple payback period is too high, making the measure difficult to implement without financial assistance.

## 1.2 Product Technical Description

The measure, addressed in this work paper, is retrofitting glass doors onto open-vertical, medium–temperature refrigerated display cases (also known as open multideck cases). Such display cases are heavily represented in a typical supermarket and can also be found in a variety of other food retail settings such as smaller grocery stores and some large convenience stores. They can be self-contained systems with a refrigeration compressor and condenser built into the case structure, but more commonly they are served by remote compressors and condensers. In supermarkets, the remote compressors are generally arranged into combined suction groups described as a multiplex system.

Although air curtains are commonly used to reduce the infiltration of non-refrigerated air into the case, infiltration of warm air and moisture is responsible for 70-80% of the refrigeration load on open-vertical refrigerated display cases.[[1]](#endnote-1) Several studies have shown that this infiltration, and thus the total refrigeration load, can be significantly reduced by adding double-paned glass to the existing display case.[[2]](#endnote-2),[[3]](#endnote-3),[[4]](#endnote-4),[[5]](#endnote-5)

In addition to retrofitting the doors and door frames, the measure may require changes to the refrigeration system serving the affected display case(s). These changes *may* include but are not limited to: replacing the expansion valve and/or EPR, adjusting the evaporator temperature/pressure set point, resizing refrigeration piping, replacing the flood back valve on the condenser, resizing the coil/piping on applicable heat reclaim systems, and replacing or removing compressors. All of these potential changes stem from the significant reduction in the overall refrigeration load. Due to the complexity in determining which system alterations will be required at a particular site in order to maintain optimum system performance, a refrigeration contractor with design experience should be consulted before proceeding with the retrofit.

## 1.3 Measure Application Type

The Measure Application Type (MAT) is Add-On Equipment (AOE): adding an EE feature or new equipment to a unit/system to make it more efficient.

The refrigerated open display cases exist as the baseline. The measure adds doors to these existing refrigerated display cases in order to make them more energy efficient.

Per Resolution E-4818 and E-4952 the new Add-On Equipment (AOE) replaces the old retrofit add-on (REA) measure application type (MAT) starting 2019.

Table  Measure Application Type[[6]](#endnote-6)

|  |  |  |
| --- | --- | --- |
| **MAT** | **Description** | **Comment** |
| AOE | Add-On Equipment | *Single baseline (above pre-existing, full measure cost required)* |

## 1.4 Product Base Case and Measure Case Data

The base case is defined as a medium-temperature, open-vertical refrigerated display case with night covers on for six hours per night. Specifications applicable to the base case measure offerings are as follows:

* The supply air temperature is 32 °F
* The coil capacity is 1,600 Btu/hr.-ft. of case.
* The case has two rows of T8 light fixtures in the canopy (16 W/ft. of case) and 10 W/ft. of evaporator coil fan electric use
* The case uses off-cycle defrost, with four defrost cycles per day

Additional details about the refrigeration system serving the display case are described in Section 2.1.2.

The measure case is defined as the retrofit of glass doors (with or without LED lighting) on a medium-temperature, open-vertical refrigerated display case (also known as an open multi-deck case).

### *1.4.1 Measure Case DEER Information*

**Net-to-Gross Ratio**

The NTG values were obtained using the DEER READI tool. The relevant NTG values for the measures in this work paper are in the table below.

Table Net to Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| 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 | Any | 0.6 |

**Spillage Rate**

Spillage rates are not tracked in work papers; they are tracked in an external document which will be supplied to the Commission Staff upon requested.

**Installation Rate**

The IR values were obtained using the DEER READI tool. The relevant IR values for the measures in this work paper are in the table below.

Table Installation Rate

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

**Effective and Remaining Useful Life**

The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for AOE measure type, and based on existing condition. The relevant EUL and RUL values for the measures in this work paper are in the table below.

Table Effective and Remaining Useful Life

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| RefgWrhs-Cond | Refrigeration Upgrades (Condenser) - Refg Warehouse | Com | HVAC ProcRefrig | 15 | 5 |

### *1.4.2 Codes & Standards Requirements Base Case and Measure Information*

Federal standards exist for new equipment with and without doors.  However, the analysis in this work paper is for retrofitting older cases, so these standards to not apply.

***Title 20:*** These measures do not fall under Title 20 of the California Energy Regulations.

***Title 24:*** These measures do not fall under Title 24 of the California Energy Regulations.

***Federal Standards:*** These measures do not fall under Federal DOE or EPA Energy Regulations.

### *1.4.3 EM&V, Market Potential, and Other Studies – Base Case and Measure Case Information*

Numerous studies have been conducted on the energy savings associated with the measures described in this paper. One commonly cited study, conducted by researchers at Southern California Edison’s Research and Thermal Test Center, found that after retrofitting doors on an open display case the cooling load attributable to infiltration was reduced by 68%.[[7]](#endnote-7) This conclusion was based on lab testing conducted with static ambient temperature and humidity levels. The retrofit differed from the measure described in the paper because the added doors included anti-sweat heaters, which introduce an additional cooling load on the refrigeration system.[[8]](#endnote-8)

Another report, based on lab testing, concluded that the cooling load of open cases decreased 66% versus cases without doors or night covers and 53% when compared to an open case with night covers in place at night.[[9]](#endnote-9)

The American Society of Heating, Refrigerating, and Air-Conditioning Engineers (ASHRAE) paid for a research project (RP-1402) to compare energy and sales results of open multi-deck vs. reach-in case for medium temperature applications.[[10]](#endnote-10) The display cases tested held alcoholic beverages and dairy and were located in 2 stores in Kansas. The report summary showed an 18% reduction in energy, using calculated compressor savings and measured refrigeration load. Even though this research compared a new open multi-deck case to a new reach-in case, not adding doors to an existing open multideck case, many of the measurements that were taken are valid for comparison to values used in this work paper including: 1) mean door open time for the reach-in case was 12 sec, occurring 6 times an hour; 2) average lighting power = 0.014 kW/ft in the open case; 3) average fan power = 0.009 kW/ft in the open case; and 4) supply to return air delta temp = 10°F for the open case and 2°F for the reach-in case.

The State of California Air Resources Board has estimated that adding doors to all viable open vertical refrigerated display cases in the state would reduce energy consumption by more than 1,000 GWH, or 5% of the total energy consumption attributed to the grocery sector.[[11]](#endnote-11)

## 

## 1.4.4 Assumptions and Calculations from other sources—Base and Measure Cases

None other than cited in this workpaper.

### *1.4.5 Time-of-Use Adjustment Factor*

Utilities are required by CPUC’s Decision 06-06-063 dated June 29, 2006 to apply time-of-use (TOU) adjustment factors on residential A/C and commercial A/C (packaged and split-system direct-expansion cooling) measures only. Since this is not an A/C measure, the TOU adjustment factor is 0. Additionally, if a measure is assigned a DEER08 load shape, i.e. the load shape starts with “DEER:” the TOU assigned to that measure should also be zero.

The specific values and results are summarized in Table 1.

Table 5 TOU Adjustment Factors

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure** | ***kWAC*** | ***kWTotal*** | **%** |
| Add Doors to Cases | 0 | 0 | 0 |

# Section 2. Calculation Methods

## 2.1 Electric Energy Savings Estimation Methodologies

The energy savings for this measure were determined by using detailed computer simulations based on the eQUEST Refrigeration Version 3.65 energy analysis program. The program calculates hour-by-hour building and refrigeration system energy consumption over an entire year (8760 hours) using CEC’s Title 24 weather data for a representative city in each CEC-defined climate zone. The most up-to-date CZ weather files were used from 2016.

The energy savings for this measure have been updated from the previous version 2 by modeling the measure in the new DEER 2020 Grocery Prototype eQUEST models. The version 3 models were generated from MAS Control V3.00.19.

The following section describes the modeling methodologies and inputs.

### 2.1.1 Model Description

Baseline Models:

There are two baseline models for all vintages – a baseline with fluorescent lighting and a baseline with LED lighting. Both baseline models include night covers in MT open cases.

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 grocery prototype models were used. These new prototypes were originally modeled with reach-in MT cases and thus they were converted to open cases for using 2.5 ft/door factor. For consistency, infiltration load, conduction load, and lighting load values from the MAS Control V3.00.19 models were used for the updated prototype models.

Efficient Models (Measure):

The Add Doors to Open MT Cases measure was modeled by reducing the infiltration load, conduction load, temperature setpoint, defrost schedule, lighting power (fluorescent lighting model only) of 195 ft of open cases, including MT\_DeliPasta, MT\_Meat3, MT\_Dairy1 and MT\_Dairy2.

All keyword and value changes are documented in the file “Add doors keyword changes.xlsx”.

### 

### 2.1.2 Model Measures

Parametric runs were performed to model the measures with adding doors on both baselines with night covers. Each of the modeling changes for all vintages and climate zones were done on four medium temp cases: MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy2. See table 6 below for baseline and modeled measure inputs.

Several manufacturers stated that most retrofits include a switch to more efficient LED case lighting but not an overall increase in lighting power density, so the Terms and Conditions state that the post-case lighting power cannot exceed the pre-case lighting power.

To model the case lighting load in this measure all existing case lighting is removed and only the new LEDs are present in the cases. Existing Energysmart™ Grocer program invoices from rebates for the Add Doors measure, where LEDs were installed along with the new doors, were reviewed to come up with a new case lighting wattage that represents all LED lights. The invoice review analyzed 5 total installations representing over 250 individual center and end lamp LED product wattages. The average LED watt per linear foot of case retrofitted was 4.17 watts. Details found in the document *Updated LED Door Wattages.xls* available upon request.

Additionally, two of the three manufacturers interviewed stated that their products did not contain anti-sweat heat in the door or mullion. It was decided to specifically prohibit door and frame heat in the measure terms and conditions as it does not appear necessary in medium temperature applications and negatively impacts energy savings. The limitations on lighting power and anti-sweat heat are outlined in the program terms and conditions in Section [1.2](#_1.2_Terms_and).

Night covers are present in a large number of existing open refrigerated display cases. In order to encourage the market to achieve the deeper savings available through retrofitting doors to such cases the workpaper assumed night covers in the base case for both measures. The model for night covers assumes that they are deployed for 6 hours a night.

Table 6 Model Changes Pre/Post

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Base Case Values** | | | | |
| **Input Description** | **DOE2.2 Components** | **DOE2.2 Keyword Input** | **Input Value** | **Explanation** |
| Night Covers | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy2 | INF-SCH | {unused} | DEER Methodology |
| Case Infiltration Load | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy3 | INF-LOAD/LEN | 1306.5 | ASHRAE Handbook - Refrigeration |
| Case Conduction and Radiation Load | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | CONDUCTION/LEN | 217.75 | ASHRAE Handbook - Refrigeration |
| Case Lighting | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | CANOPY-KW/LEN | HA09: 0.01833  HAxx: 0.004171 | DEER Grocery Prototype |
| Case Temperature Setpoint | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | TEMP-SETPT | 31 | DEER Grocery Prototype |
| Defrost Schedule | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | DEFROST-SCH | "Defrost\_5\_Sched" | DEER Grocery Prototype |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Case Values** | | | | |
| **Input Description** | **DOE2.2 Components** | **DOE2.2 Keyword Input** | **Input Value** | **Explanation** |
| Case Infiltration Load | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy3 | INF-LOAD/LEN | 261.3 | 80% Reduction |
| Case Conduction and Radiation Load | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | CONDUCTION/LEN | 91.45 | 58% Reduction (conduction and radiation) |
| Case Lighting | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | CANOPY-KW/LEN | 0.004171 | Program invoice review |
| Case Temperature Setpoint | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | TEMP-SETPT | 35 | Allows for proper cooling and maintain product integrity without overcooling |
| Defrost Schedule | MT\_DeliPasta, MT\_Meat3, MT\_Dairy1, MT\_Dairy4 | DEFROST-SCH | "Defrost\_3\_Sched" | Less defrost required due to less infiltration of moisture into the case |

The base case and post-implementation models for each climate zone are identical with the exception of the changes detailed above.

### 2.1.3 Final Electrical Energy Savings Calculation

The energy savings value was calculated as the difference between the annual whole building electrical consumption output values in the base case and the post-implementation models. The difference was divided by the number of units of measure implementation that were modeled.

Equation 1



Where:

Electric Savings = The annual electric savings achieved per unit of implemented measure.

ElectricUseBASECASE = The annual electric consumption in the base case model.

ElectricUsePOST = The annual electric consumption in the post-implementation model.

UnitCount = The total number of feet of refrigerated display case for which the measure was modeled in a particular model. Always equal to 120 ft.

## 2.2 Demand Reduction Estimation Methodologies

The demand savings were derived from the same models that were used to develop the energy savings values. They were calculated as the difference between the peak power demand in the base case and the post-implementation model during the CPUC defined peak demand period for each climate zone. These peak demand periods have been adjusted for the 2009 weather data that was used for modeling. The total difference was divided by the number of units of measure implementation that were modeled.

Equation 2



Where:

Demand Savings = The demand savings achieved at the electric system’s peak demand as defined by the CPUC per unit of implemented measure.

PeakBASECASE = The average whole-building power demand occurring during the CPUC’s defined peak period for the appropriate climate zone in the base case model.

PeakPOST = The average modeled whole-building power demand occurring during the CPUC’s defined peak period for the appropriate climate zone in the post-implementation model.

## 2.3 Gas Energy Savings Estimation Methodologies

The gas savings value was calculated as the difference between the annual whole building gas consumption in the base case and the post-implementation models. The difference was divided by the number of units of measure implementation that were modeled.

Equation 3



Where:

Gas Savings = The annual gas savings achieved per unit of implemented measure.

GasUseBASECASE = The annual gas consumption in the base case model.

GasUsePOST = The annual gas consumption in the post-implementation model.

# Section 3. Load Shapes

## 3.1 Base Case Load Shapes

The base case load shape follows a typical commercial refrigeration load shape. This load shape closely follows outside temperatures, with the highest load associated with high outside temperatures and the smallest load associated with cooler outside temperatures. Figure 2 - Base Case Daily Load Profiles displays the load profile of the base case models used for Climate Zone 3 over the course of a typical day in July.



Figure 1 - Base Case Daily Load Profiles

## 3.2 Measure Load Shapes

For purposes of the net benefits estimates in the E3 calculator, what is required is the load shape that ideally represents the difference between the base equipment and the installed energy efficiency measure. This difference in load profile is what is called the Measure Load Shape and is the preferred load shape for use in the net benefits calculations.

The E3 Calculator contains a fixed set of load shapes selections that are the combination of the hourly avoided costs and the load shape data that was available at the time of the tool’s creation. In the E3 Calculator, the load shape that most closely fits this measure is the ‘Commercial Refrigeration’ load shape because a majority of the savings are the direct result of a consistent infiltration cooling load reduction on the site’s refrigeration system. The infiltration reduction should parallel the energy use of the base case load shape. One exception is that the savings during night hours (11p-5a) are reduced when night covers are in place in the base case. Figure 3 - Measure Savings Daily Load Profile displays the modeled measure savings profile for each of the measures in Climate Zone 3 over the course of a July day.



Figure 2 - Measure Savings Daily Load Profile

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Costs

The addition of doors to an existing refrigerated case is an AOE measure. As such, there are no applicable base case costs.

Table 7 Base Case Cost

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Application Type** | **Baseline** | **Material Cost** | **Labor / Installation Cost** | **Total Base Case Cost** |
| HA09 | AOE | Existing Vertical Med. Temp Refrigerated Display Case w/ Night Covers | $0.00 | $0.00 | $0.00 |
| RF013 | AOE | Existing Vertical Med. Temp Refrigerated Display Case w/Night Covers and Fluorescent Lighting | $0.00 | $0.00 | $0.00 |

*Note: All costs are expressed in $ per linear foot of case.*

## 4.2 Measure Case Costs

The following Measure Application Type, AOE, is appropriate to this measure. The Measure Case Cost is the full measure cost.

Table 8 Measure Case Cost

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Application Type** | **Measure** | **Material Cost** | **Labor / Installation Cost** | **Total Measure Case Cost** |
| HA09 | AOE | Add Doors (w/o LED) to Open Vertical, Med. Temp Refrigerated Case w/ Night Covers | $301.84 | $87.79 | $389.63 |
| RF013 | AOE | Add Doors (with LED) to Open Vertical, Med. Temp Refrigerated Case w/ Night Covers | $331.12 | $87.79 | $418.91 |

*Note: All costs are expressed in $ per linear foot of case.*

See Appendix B for details supporting the following section.

The average equipment cost was developed using CLEAResult invoices from actual projects in 2016-17.   The measure materials include door and door frames and may also include shelving, a new expansion valve, and some additional piping. Taking the average of these projects resulted in a material cost of $301.84. These costs are lower than the $456.31 found in 2012.

The above cost was obtained by only averaging projects without LED lighting upgrades.  However, when doors are added it is also common to include the installation of LED lights.  Therefore, invoices for these projects were analyzed as well.  As a result the calculated average cost for the new door with LED lighting is $331.12 per linear foot.

The average labor cost was found to be $87.79 which is higher than the 2012 estimate of $65.24.  This new estimate is based on actual invoice data rather than engineering assumptions used in 2012, so they are more accurate.   Based on CLEAResult’s discussions with a major refrigeration services contractor, the cost assumes each 8-ft. refrigerated case requires a new expansion valve and 50 feet of new copper piping. The labor also includes time to scope the project, install the doors, and commission the refrigeration system controls.

The total measure cost per foot of case, including all labor and materials required to retrofit the doors and ensure that the refrigeration system is in good functioning order, is $389.63 without LED, and $418.91 with LED. The values do not change when night covers are in place in the base case.

## 4.3 Incremental & Full Measure Costs

### 4.3.1 Full Measure Cost

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

This measure’s Measure Application type is AOE for a single baseline period, so the Full Measure Cost (FMC) is represented by the equation below:

FMC = Measure Material Cost + Measure Labor Cost

FMC (Door w/o LED) = $301.84 material per Len-ft + $87.79 labor per Len-ft = $389.63 per Len-ft

FMC (Door w/LED) = $331.12 material per Len-ft + $87.79 labor per Len-ft = $418.91 per Len-ft

Table 9 Base Case and Measure Cost

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure ID** | **Measure Application Type** | **Base Case Total Cost** | **Measure Case Total Cost** |
| HA09 | AOE | $0.00 | $389.63 |
| RF013 | AOE | $0.00 | $418.91 |

## Appendix A: Measure Cost Analysis

See attached file “Appendix A Cost Analysis\_Invoice Data.xlsx”

# References

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