Work Paper SCE17LG089

**Revision 0**

**Southern California Edison**

**Interior Bi-Level Stairwell Lighting**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | LT-48107, LT-69302 |
| **Measure Description** | Bi-level or Dimming Stairwell Fixtures (48in T8 Linear Fluorescent) |
| **Base Case Description** | Stairwell light fixtures (48in T8 Linear Fluorescent) with no control |
| **Units** | Fixture |
| **Energy Savings** | Refer to Excel Calculation Attachment |
| **Full Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Incremental Measure Cost ($/unit)** | Refer to Excel Calculation Attachment |
| **Effective Useful Life** | ILtg-OccSens: 8yrs (EUL)  ILtg-Lfluor-Fix: 5.3yrs (RUL) |
| **Measure Installation Type** | Retrofit (RET)  Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | NonRes-sAll-mLtgCtrl: 0.6 (NonRes downstream)  NonRes-sAll-mLtgCtrl-htr: 0.89 (NonRes direct install)  Res-Default>2: 0.55 (Res downstream)  Res-Default-HTR-di: 0.85 (Res direct install) |
| **Important Comments** | This work paper has a complementary Ex Ante Database data set that will be provided in a separate submission to the California Public Utilities Commission (CPUC). |

# Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Rev** | **Date** | **Author** | **Summary of Changes** |
| 0 | 10/25/16 | Kara Vega (TRC) | * This workpaper is an update of SCE13LG089.2 * Reviewed Title 24 2016 for updates to the baseline and verified that based on the code language there are no updates needed to the baseline. The code language in the workpaper was updated to reflect Title 24 2016. * Updated costs based on WO017 * Updated RUL code to be consistent with READI tool |

# Commission Staff and Cal TF Comments

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Rev** | **Party** | **Submittal Date** | **Comment Date** | **Comments** | **WP Developer Response** |
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Cal TF website: <http://www.caltf.org/>

# Section 1. General Measure & Baseline Data

## 1.1 Measure Description & Background

**Base, Standard, and Measure Cases**

|  |  |
| --- | --- |
| **Case** | **Description of Typical Scenario** |
| Measure | 1. 4-foot 2-lamp T8 and 2-foot 1-lamp T8 bi-level on/off fixture, with occupancy sensor    * When all lamps are on, the fixture consumes 67W.    * When the stairwell is unoccupied, the occupancy sensor will shut off the two 4-foot lamps. The 2-foot emergency lamp stays on, consuming 15W.    * The percentages of time the fixture spends in the on and off modes are described in Section 2. 2. 4-foot 2-lamp T8 bi-level dimming fixture, with occupancy sensor    * At high output, the fixture consumes 62W.    * When the stairwell is unoccupied, the occupancy sensor will dim the fixture to a low output setting. The fixture consumes 28W in low mode.    * The percentages of time the fixture spends in the on and off modes are described in Section 2. |
| Existing Condition | 4-foot 2-lamp T8 fixture, always on, without occupancy sensor, consuming 51W |
| Code/Standard | 4-foot 2-lamp T8 fixture, with occupancy sensor   * When the stairwell is unoccupied, the occupancy sensor will dim the fixture to 50% power (the minimum power reduction required by Title 24). |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  | LT-48107 |  | Bi-Level On/Off Controls replacing (2) 48in T8 Linear Fluorescent |
|  |  | LT-69302 |  | Bi-Level Dimming Controls replacing (2) 48in T8 Linear Fluorescent |

**Eligibility requirements**

* Retrofit (RET) savings only apply to base case fixtures that are not equipped with automatic controls such as occupancy sensors, timers or photocells.
* Fixtures must be located in an interior stairwell.

## 1.2 Technical Description

The measure case includes two types of bi-level fixtures:

* **LT-48107:** An on/off fixture which includes two 4-foot T8 lamps and one low wattage 2-foot T8 lamp equipped with electronic ballast. At full level output all three lamps are on and the fixture consumes 67 Watts (0.067 kW) per fixture and at low level output the 2-foot lamp is on and the fixture consumes 15 Watts (0.015 kW) per fixture (Attachment 2). The 2-foot lamp is always on.
* **LT-69302:** A dimming fixture with two 4-foot T8 lamps with an electronic dimming ballast which at full level output consumes 62 Watts (0.062 kW) [410] per fixture and at low level output consumes 28 Watts (0.028 kW) [410] per fixture. The low level output wattage is based on a survey of market-available bi-level fixtures.

Neither of the above measure cases is recommended for Refrigerated Warehouse applications because fluorescent relative light output drops about 2/3 at 32°F vs its 77°F rated temperature.

The base case includes a single type of fixture:

* A fixture equipped with two 4-foot 30 W T8 lamps equipped with a premium instant start electronic ballast (F42WLL) consuming 51 Watts (0.051 kW) [382] per fixture.

## 1.3 Installation Types and Delivery Mechanisms

The install types and delivery mechanisms that are available for these measures are:

Retrofit (RET)

* Financial Support: Down-Stream Incentive - Deemed
* Financial Support: Direct Install

The Non Residential Direct Install program quality control ensures correct documentation of existing measure, base case, and specification of the energy efficient product installed.  SCE requires a detailed Product Location Form (PLF) for each project submitted for rebate or incentive.  The PLF is a form which information for measures installed in all building types related to the Non Residential Direct Install program.  The PLF contains the following fields: Service Account Address, Measures Proposed/Installed, Product Make/Model, Install Locations (detailed to define separate spaces/floors, as well as specific locations within the space including but not limited to:  Bathrooms, Hallways, Meeting Rooms, Offices, Warehouse, etc.).

Customers are solicited to participate primarily through field visits.  Contractors conduct energy consultation and provide recommendation that can help eligible customers use less energy.  If the customer agrees, the Direct Install contractor will help them complete an authorization form and schedule an installation appointment.

SCE can also provide photos to show measure functionality and a sample close up photos to substantiate the measure base case where applicable.  These photos would be part of the required project package.  The project package is identified with the Service Account Number and attached to SCE’s SMART database (SCE Project Tracking System) at each specific project level. The above described information is entered and tracked in the program’s tracking database.  This level of data is provided in the Participation Data that is provided to the CPUC on a quarterly basis.

Replace on Burnout (ROB)

* Mid-Stream Programs: Mid-Stream Incentive

**Installation Type Descriptions**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Installation Type** | **Savings** | | **Life** | |
| 1st Baseline (BL) | 2nd BL | 1st BL | 2nd BL |
| Replace on Burnout (ROB) | Above Code or Standard | N/A | EUL | N/A |
| Retrofit or Early Replacement (RET/ER) | Above Customer Existing | Above Code or Standard | RUL | EUL-RUL |

A delivery mechanism is a delivery method paired with an incentive method. Delivery mechanisms are used by programs to obtain program participation and energy savings.

**Delivery Method Descriptions**

|  |  |
| --- | --- |
| **Delivery Method** | **Description** |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Mid-Stream Programs | *See Mid-Stream Incentive in the Incentive Method Descriptions table.* |

**Incentive Method Descriptions**

|  |  |
| --- | --- |
| **Incentive Method** | **Description** |
| Direct Install | The program implements energy efficiency measures for qualifying customers, at no cost to the customer. |
| Down-Stream Incentive | The customer installs qualifying energy efficient equipment and submits an incentive application to the utility program. Upon application approval, the utility program pays an incentive to the customer. Such an incentive may be deemed or customized. |
| Mid-Stream Incentive  Mid-Stream Buy Down | The program gives a financial incentive to a midstream market actor (distributor, vendor, or retailer) to encourage the promotion of efficient measures. Buy Down means that the incentive is required to be passed down to the end-use customer. |

## 1.4 Measure Parameters

### 1.4.1 DEER Data

DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Used for Workpaper?** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | No |
| DEER Measure Case | No |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | N/A |
| DEER Version | N/A |
| Reason for Deviation from DEER | DEER does not contain these measures. |
| DEER Measure IDs Used | N/A |

**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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| NonRes-sAll-mLtgCtrl | Lighting controls (not listed elsewhere) | Com | Any | PreRebDown | 0.60 |
| NonRes-sAll-mLtgCtrl-htr | Lighting controls (not listed elsewhere) | Com | Any | DirInstall | 0.89 |
| Res-Default>2 | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | Any | All | 0.55 |
| Res-Default-HTR-di | All other EEM with no evaluated NTGR; direct install hard-to-reach only. | Res | Any | DirInstall | 0.85 |

Note: Direct install measures that are not hard-to-reach will use the default NTG value.

**Regarding the Multi-Family Energy Efficiency Rebate (MFEER) Direct Install Program**

This work paper includes measures that are offered via direct install activities into hard-to-reach (HTR) customer homes. “Final Resolution E-4700”, dated December 18, 2014, defines specific criteria to classify customer homes as HTR. The “Required Corrections to Measure Level Input Parameters Identified by Commission Staff per D.14-10-046 Order Paragraph 16”, dated November 3, 2014, includes additional clarification for the geographic criteria.

SCE’s Multi-Family Energy Efficiency Rebate (MFEER) program addresses the ongoing concern with “split incentives”, where the residents are not the owners of the property, so they lack incentive to improve their energy usage. Similarly, the property owners do not live on-site and pay higher utility expenses due to inefficient appliances, thus lack any incentive to upgrade. The MFEER is designed to drive this customer segment toward participation by offering property owners a variety of energy efficiency measures and services. The MFEER program will offer and track measure installations in both common and dwelling areas of multifamily complexes and common areas of mobile home parks and condominiums. Measures offered via direct install activities in both common and dwelling areas of multifamily complexes and common areas of mobile home parks and condominiums will receive the HTR NTG. Other measures in the MFEER program will receive default NTG (NTGR\_ID: Res-Default>2), unless otherwise specified in DEER.

**Regarding the Commercial Direct Install Programs**

This work paper includes measures that are offered via direct install activities into hard-to-reach (HTR) customer facilities. “Final Resolution E-4700”, dated December 18, 2014, defines specific criteria to classify customer facilities as HTR and also states that two criteria are sufficient to identify HTR customers if one of the criteria met is the geographic criteria.

SCE’s Commercial Direct Install program delivers free and low cost energy efficiency hardware retrofits through installation contractors to reduce peak demand and energy savings for small and medium commercial customers. The barriers for customer participation include limited capital resources, lack of expertise and understanding of the understanding of the benefits of energy efficiency, a suspicion of the “free offer” and its legitimacy, and language and cultural barriers. The program also addresses the ongoing concern with “split incentives”, where the customer is not the owner of the property, and therefore, lack incentive to improve their energy usage. SCE’s Commercial Direct Install program will track the following three (3) customer data points to identify direct install activities in HTR customer facilities. If geography and business size criteria are satisfied, SCE will identify the customer as HTR. If geography and language criteria are satisfied, SCE will identify the customer as HTR. Other measures in the Commercial Direct Install program will receive default NTG (NTGR\_ID: Com-Default>2), unless otherwise specified in DEER.

* **Business Size** – Customer must have less than ten employees
* **Language** – Customer’s primary language spoken is not English
* **Geography** – Businesses in areas other than the United States Office of Management and Budget (OMB) Combined Statistical Areas (CSA) of the San Francisco Bay Area, the Greater Los Angeles Area and the Greater Sacramento Area or the OBM metropolitan statistical areas or San Diego County.

The “Required Corrections to Measure Level Input Parameters Identified by Commission Staff per D.14-10-046 Order Paragraph 16”, dated November 3, 2014, includes additional clarification for the geographic criteria:

“Notes on OMB CSA designations:

The OMB has designated a 12-county CSA titled the San Jose-San Francisco-Oakland, CA Combined Statistical Area which includes the nine counties of Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma which border the San Francisco Bay plus the three counties of San Joaquin, Santa Cruz, and San Benito that are economically tied to the nine counties that that border the San Francisco Bay.

The OMB definition of this CSA includes Los Angeles, Orange, San Bernardino, Riverside and Ventura counties.

The OMB definition of this CSA includes Sacramento, Yolo, El Dorado, Placer, Sutter, Yuba, and Nevada counties.”

**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.

**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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below. Since the base case is a linear fluorescent fixture, the RUL is not based on the EUL of an occupancy sensor. The RUL is 1/3 of a LF fixture’s EUL (16 years / 3 = 5.3 years).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL ID** | **RUL (Years)** |
| ILtg-OccSens | Occupancy Sensors | Com | Lighting | 8 | ILtg-Lfluor-Fix | 5.3 |

### 1.4.2 Codes and Standards Analysis

Title 24 2016 [496] Section 130.1(c)6 & 7 states:

**Areas where partial ON/OFF occupant sensing controls are required** in addition to complying with Section 130.1(c)1.

1. Lighting installed in corridors and stairwells shall be controlled by occupant sensing controls that separately reduce the lighting power in each space by at least 50 percent when the space is unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

**Areas where partial ON/OFF occupant sensing controls are required** instead of complying with Section

130.1(c)1.

1. Lighting in stairwells and common area corridors which provide access to guestrooms and dwelling units of high-rise residential buildings and hotel/motels shall be controlled with occupant sensing controls that automatically reduce lighting power by at least 50 percent when the areas are unoccupied. The occupant sensing controls shall be capable of automatically turning the lighting fully ON only in the separately controlled space, and shall be automatically activated from all designed paths of egress.

**EXCEPTION to Section 130.1(c)7A:** In corridors and stairwells in which the installed lighting power is 80 percent or less of the value allowed under the Area Category Method, occupant sensing controls shall reduce power by at least 40 percent.

Title 20 2015 [493] Section 1605.3(G) provides regulations for occupant sensing devices for emergency lighting, but not for stairwell lighting fixtures.

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | 2016 Non-Residential Compliance manual, Section 130.1(c)6 & 7 | January 1, 2017 |
| Title 20 (2015) | N/A | N/A |

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

### 1.5.1 Bi-level Stairwell Fixture Performance Final Report

The Bi-level Stairwell Fixture Performance Final Report described the energy savings, demand reduction, and safety code acceptability of occupancy-based standby lighting in California. The values determined for percentage of time in dimmed mode were used in this work paper [410].

## 1.6 Data Quality and Future Data Needs

The bi-level stairwell fixture report mentioned in Section 1.5.1 was released in October 2004, over a decade ago. Updated data on occupancy rates would improve this work paper’s accuracy.

# Section 2. Calculation Methodology

The measure case includes two types of bi-level fixtures:

* **LT-48107:** An on/off fixture which includes two 4-foot T8 lamps and one low wattage 2-foot T8 lamp equipped with electronic ballast. At full level output all three lamps are on and the fixture consumes 67 Watts (0.067 kW) per fixture and at low level output the 2-foot lamp is on and the fixture consumes 15 Watts (0.015 kW) per fixture (Attachment 2). The 2-foot lamp is always on.
* **LT-69302:** A dimming fixture with two 4-foot T8 lamps with an electronic dimming ballast which at full level output consumes 62 Watts (0.062 kW) [410] per fixture and at low level output consumes 28 Watts (0.028 kW) [410] per fixture. The low level output wattage is based on a survey of market-available bi-level fixtures.

The base case includes a single type of fixture:

* A fixture equipped with two 4-foot 30 W T8 lamps equipped with a premium instant start electronic ballast (F42WLL) consuming 51 Watts (0.051 kW) [382] per fixture.

The calculations below are for LT-69302 Bi-Level Dimming Controls replacing (2) 48in T8 Linear Fluorescent. Additional details and the values used in the Calculation Template (Attachment 1), for both measures, can be found in Attachment 3.

**Occupancy Rates**

Based on a the Final Report of Bi-level Stairwell Fixture Performance from the CEC Lighting Research Project [410], the percentage of time in the low output mode ranged from 62% to 82% on weekdays and 85% to 97% on weekends. When the fixture is in low output mode the space is assumed to be unoccupied. From a weighted average calculation using the conservative time saving estimates, the average weekly unoccupied and occupied rates are as follows:

**Interactive Effects**

For the building types in this work paper, stairwells are assumed to be unconditioned, so interactive effects are not used.

**Peak Demand Reduction (RET 1st Baseline)**

Example: Bi-Level Dimming Controls replacing (2) 48in T8 Linear Fluorescent

The Energy Efficient Watts/unit are calculated by a time-weighted average using the occupancy rates as follows:

Therefore,

**Peak Demand Reduction (RET 2nd Baseline, ROB 1st Baseline)**

The 2nd baseline uses the code baseline that would dim the lighting to 50%. Utilizing the same measure that draws 62W, the unoccupied Watts dimmed results in 31W.

**Energy Savings (RET 1st Baseline)**

Stairwell fixtures are assumed to be on 24/7, so the annual hours of operation are 8,760 hours/year.

**Energy Savings (RET 2nd Baseline, ROB 1st Baseline)**

# Section 3. Load Shapes

The ideal load shape for net benefits estimates would represent the difference between the base case and measure case. The closest load shapes that are applicable to the measures in this work paper are listed in the table below.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **Load Shape** | **E3 Alternate Building Type** |
| Assembly | Occupancy Sensor | Misc.\_Commercial |
| Education - Community College | Occupancy Sensor | K\_thru\_12\_School |
| Education - Primary School | Occupancy Sensor | K\_thru\_12\_School |
| Education - Secondary School | Occupancy Sensor | K\_thru\_12\_School |
| Education - University | Occupancy Sensor | K\_thru\_12\_School |
| Health/Medical - Hospital | Occupancy Sensor | Misc.\_Commercial |
| Health/Medical - Nursing Home | Occupancy Sensor | Misc.\_Commercial |
| Lodging - Hotel | Occupancy Sensor | Hotel\_Motel |
| Lodging - Motel | Occupancy Sensor | Hotel\_Motel |
| Manufacturing - Bio/Tech | Occupancy Sensor | Industrial |
| Manufacturing - Light Industrial | Occupancy Sensor | Industrial |
| Office - Large | Occupancy Sensor | Large\_Office |
| Office - Small | Occupancy Sensor | Small\_Office |
| Retail - Multistory Large | Occupancy Sensor | Large\_Retail\_Store |
| Storage - Conditioned | Occupancy Sensor | Misc.\_Commercial |
| Storage - Unconditioned | Occupancy Sensor | Misc.\_Commercial |
| Warehouse - Refrigerated | Occupancy Sensor | Misc.\_Commercial |
| Residential Multi-family | Occupancy Sensor | Misc.\_Commercial |

# Section 4. Costs

WO017 provides material and labor costs for bi-level linear fluorescent fixtures for garage and stairwell lighting. Note that the costs do not include lamp costs.

## 4.1 Base Case Cost

The labor cost is 1.26 hours \* $75.45/hour + $24.30 (miscellaneous costs) = $119.37.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **Base Case** | **WO017 Description** | **Material Cost** | **Labor Cost** |
| LT-48107, LT-69302 | 4-foot T8 fixture (51W) | T8, 48 inch, 2-lamp, 51 watt, instant start ballast, surface mounted wrap (lamps not included) | $56.87 | $119.37 |

## 4.2 Measure Case Cost

The labor cost is 1.32 hours \* $75.46/hour + $28.19 (miscellaneous costs) = $127.80.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **Measure** | **WO017 Description** | **Material Cost** | **Labor Cost** |
| LT-48107 | 4-foot 2-lamp T8 and 2-foot 1-lamp T8 (67W/15W) bi-level on/off fixture | Two lamp 4 foot 62 watt linear fluorescent fixture with integrated occupancy sensor - no dimming w/ emergency ballast | $414.17 | $127.80 |
| LT-69302 | 4-foot 2-lamp T8 bi-level dimming fixture (62W/28W) | Two lamp 4 foot 67 watt linear fluorescent fixture with integrated occupancy sensor - w/ dimming w/ emergency ballast | $468.97 | $127.80 |

## 4.3 Full and Incremental Measure Cost

**Full and Incremental Measure Cost Equations**

|  |  |  |  |
| --- | --- | --- | --- |
| **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| ROB | (MEC + MLC) – (BEC + BLC) | (MEC + MLC) – (BEC + BLC) | N/A |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |

MEC = Measure Equipment Cost; MLC = Measure Labor Cost

BEC = Base Case Equipment Cost; BLC = Base Case Labor Cost

**Full and Incremental Costs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure** | **Installation Type** | **Incremental Measure Cost** | **Full Measure Cost** | |
| **1st Baseline** | **2nd Baseline** |
| LT-48107 | ROB | $365.73 | $365.73 | N/A |
| RET | $365.73 | $541.97 | $365.73 |
| LT-69302 | ROB | $420.53 | $420.53 | N/A |
| RET | $420.53 | $596.77 | $420.53 |

# Attachments

1. 
2. 

1. 

# References



[382] Appendix B: Table of Standard Fixture Wattages and Sample Lighting Table

[410] Lighting Research Program Project 5.1 Bi-Level Stairwell Fixture Performance

[496] 2016 Building Energy Efficiency Standards for Residential and Nonresidential Buildings (Title 24)