Work Paper SCE17LG092

**Revision 0**

**Southern California Edison**

**Fluorescent Lamp to Fluorescent Lamp**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | LT-21844, LT-97103 |
| **Measure Description** | 48in Reduced Wattage T8 Linear Fluorescent Lamp and Ballast  46in Energy Saver T5 Linear Fluorescent Lamp and Ballast |
| **Base Case Description** | 48in Standard Efficiency T8 Linear Fluorescent Lamp and Ballast  46in Standard Efficiency T5 Linear Fluorescent Lamp and Ballast |
| **Units** | Per Lamp |
| **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-Lfluor-Elec, ILtg-T5: Rated Life of Ballast (70,000 hours) / HOU, OR 15 years, whichever is less |
| **Measure Installation Type** | Replace on Burnout (ROB) |
| **Net-to-Gross Ratio** | NonRes-sAll-mLFOth-Deemed: 0.60  Res-Default>2: 0.55 |
| **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 | 11/2/16 | Kara Vega (TRC) | * This work paper is an update of SCE13LG092.2. * New Calculation Template for 2017 program year. * Language within the work paper was updated to reflect lamp and ballast replacement. * Removed solution code LT-69513 * Updated requirements based on 2016 Solutions Directory * Added Mid-Stream Programs * Updated energy impacts and equipment costs based on DEER2017 values |

# 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 | Reduced wattage T8 linear fluorescent lamp: 28W or 25W and ballast  Energy Saver T5 linear fluorescent lamp: 49W and ballast |
| Existing Condition | Standard efficiency T8 linear fluorescent lamp: 32W  Standard efficiency T8 linear fluorescent lamp: 54W |
| Code/Standard | Standard efficiency T8 linear fluorescent lamp: 32W  Standard efficiency T8 linear fluorescent lamp: 54W |
| Industry Standard Practice | N/A |

Measures and Codes

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Codes** | | | | **Measure Name** |
| SCG | SDG&E | SCE | PG&E |
|  |  | LT-21844 |  | (1) 48in Reduced Wattage (28W) T8 Linear Fluorescent replacing (1) 48in T8 Linear Fluorescent (32W) |
|  |  | LT-97103 |  | (1) 48in Reduced Wattage (25W) T8 Linear Fluorescent replacing (1) 48in T8 Linear Fluorescent (32W) |

**Eligibility Requirements**

**Requirements from the 2016 Solutions Directory**

General Lighting Eligibility [A]

* All new lighting fixtures, retrofit kits, and components must carry the appropriate, designated Underwriters Laboratory (UL) or Electrical Testing Laboratory (ETL) label.
* Customer should make sure that new lighting equipment is compatible with existing equipment and controls.
* When applicable, lighting fixtures must meet existing case and proposed case requirement tables.
* New fixture or lamp wattage must be less than the wattage of lamp being replaced.

Interior Standard T8 Lamp to Reduced Wattage T8 Lamp Retrofit Requirements

* New T8 lamps must be Consortium for Energy Efficiency (CEE) approved.
* Existing 4-foot 32-watt T8 fluorescent lamps must be replaced, one for one, with 4-foot 28-watt or 25-watt T8 fluorescent lamps.

T8 or T5 Linear Fluorescent Lamps and Electronic Ballasts – General Requirement

* Lamps and ballasts must be replaced, one for one, with T8 or T5 lamps with electronic, high-frequency (greater than or equal to 20 kHz) ballasts.
* Proposed ballasts must have a power factor of greater than or equal to 0.90.
* At full light output, ballasts must have a total harmonic distortion of less than or equal to 20%.
* T5 lamp installations must use programmed start or programmed rapid-start ballasts.
* Customers installing T5 lamps for direct lighting in low ceilings (under 15’) should consult a lighting professional to address the possibility of excessive glare.
* Replacement lamps and ballasts must meet the color rendering index (CRI) and rated lamp life standards listed in the 2016 Solutions Directory Lamp and Ballast requirement table.
* Manufacturer’s specification sheets for lamps and ballasts must be provided.
* T5HO replacement lamps must have a lamp life rating of 20,000 hours or greater. All lamps must meet the minimums of rated lamp life at 3 hours/start.

## 1.2 Technical Description

A linear fluorescent lamp is a mercury-vapor gas-discharge lamp that utilizes electric current to excite the low pressure gas contained to produce fluorescent light. Luminous efficacy, or how much light is produced by a lamp in comparison to the energy it consumes, is generally higher in fluorescent lamps than in most incandescent lighting, thus making it the preferred type in offices and warehouses where consistent, prolonged operation is required. However, while it is more energy efficient, fluorescent lamps require a ballast to regulate the current through the lamp, consequently increasing the initial cost. An instant-start ballast lamp is used in one of the measures addressed within this work paper. This ballast starts lamps without heating by using an adequately high voltage to break down the gas and mercury column. Instant-start ballasts are the most efficient of the linear fluorescent ballast types, but also allow for fewer starts. Consequently, instant-start ballasts are ideal in places where light usage is more constant rather than frequently being turned off and on.

The types of linear tubular lamps being replaced in this work paper are 1 inch diameter T8 lamps which generally produce lighting in the range of 80 lumens/watt and 5/8 inch diameter T5 lamps that produce lighting in the range of 100 lumens/watt. The measure objective is to replace current T8 and T5 linear fluorescent lamps with reduced wattage T8 and T5 bulbs, respectively, of the same length. Installation of a new lamp with adequate lumen output and lower power load for the duration of its expected useful life (EUL) will result in energy savings from the baseline.

## 1.3 Installation Types and Delivery Mechanisms

**Installation Types:**

* ROB

**Delivery Mechanisms:**

These measures are offered by several SCE programs, including: Express Solutions, Mid-Stream Programs, Partnerships, Commercial Direct Install, and Partnerships Direct Install. None of the measures are considered Hard-To-Reach.

* Financial Support: Down-Stream Incentive - Deemed
* Financial Support: Direct Install
* Partnership: Down-Stream Incentive - Deemed
* Partnership : Direct Install
* Mid-Stream Programs: Mid-Stream Incentive/ Mid-Stream Buy Down

**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 |

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.* |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |

**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 | Yes |
| DEER Measure Case | Yes |
| DEER Building Types | Yes |
| DEER Operating Hours | Yes |
| DEER eQUEST Prototypes | No |
| DEER Version | DEER 2017, READI v2.4.7 |
| Reason for Deviation from DEER | Uses READI measures directly |
| DEER Measure IDs Used | C-In-LFLmpBlst-T8-48in-28w+El-IS-NLO(27w)-dWP3-2  C-In-LFLmpBlst-T8-48in-25w+El-IS-NLO(26w)-dWP4-2  C-In-LFLmpBlst-T5-46in-49w+El-IS-NLO(49.3w)-dWP4  R-In-LFLmpBlst-T8-48in-28w+El-IS-NLO(27w)-dWP3-2  R-In-LFLmpBlst-T8-48in-25w+El-IS-NLO(26w)-dWP4-2  R-In-LFLmpBlst-T5-46in-49w+El-IS-NLO(49.3w)-dWP4 |

**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.

**Net-to-Gross Ratio**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Measure Delivery** | **NTGR** |
| NonRes-sAll-mLFOth-Deemed | Nonresidential Linear Fluorescent: measures not listed elsewhere; all delivery mechanisms | NonRes | Any | Deemed | 0.60 |
| Res-Default>2 | All other EEM with no evaluated NTGR; existing EEM with same delivery mechanism for more than 2 years | Res | Any | Any | 0.55 |

**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. The GSIAs “Com-LF-SCE” and “MFm-LF-SCE” were not used because those are for fixtures, not lamps.

**Gross Savings Installation Adjustment**

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

**Effective and Remaining Useful Life**

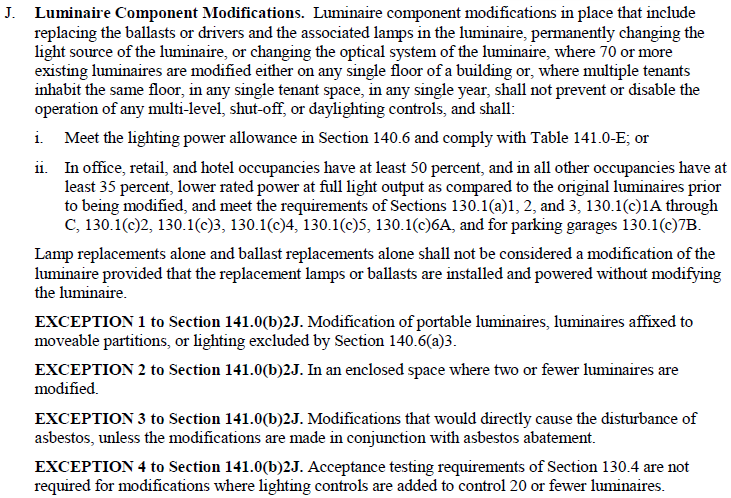
The EUL and RUL values were obtained using the DEER READI tool. DEER defines the RUL as 1/3 of the EUL value. The RUL value is only applicable to the first baseline period for an RET measure with an applicable code baseline. The relevant EUL and RUL values for the measures in this work paper are in the table below.

**Effective and Remaining Useful Life**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| ILtg-Lfluor-Elec | Linear Fluorescent with Electronic Ballast | Com | Lighting | Rated Life of Ballast (70,000 hours) / HOU, OR 15 years, whichever is less | N/A |
| ILtg-T5 | HID Lighting (T-5) | Com | Lighting | Rated Life of Ballast (70,000 hours) / HOU, OR 15 years, whichever is less | N/A |

### 1.4.2 Codes and Standards Analysis

Lighting power densities (LPD) for spaces for lighting fixtures defined as ”Luminaire Component Modifications” are regulated by Standards Table 141.0-E of California’s Title 24 2016 Building Energy Efficiency Standards [496]. The measures addressed in this work paper fall under Section 141.0(b)2J of the Title 24 Standards.



Since the measures addressed within this work paper include replacing the ballasts and the associated lamps in the luminaire, they are determined to be “Luminaire Component Modifications” and thus must comply with Table 141.E in Title 24 2016, and a lighting power density (LPD) analysis must be performed. However, this paper uses measures from DEER in lieu of performing an LPD analysis. Refer to Section 2 for more information.

2012 Federal Standards for General Service Fluorescent Lamps (GSFL) issued by Department of Energy contain an Energy Conservation Standard that applies to various linear fluorescent lamp types [B].

2015 Title 20 Appliance Efficiency Regulations issued by the California Energy Commission contains standards for fluorescent lamp ballasts and for federally-regulated general service fluorescent lamps that applies to all fluorescent lamp ballasts and fluorescent lamp types [493].

Code Summary

|  |  |  |
| --- | --- | --- |
| **Code** | **Reference** | **Effective Dates** |
| Title 24 (2016) | 2016 Building Efficiency Standards, Section 141.0(b)2J | January 1, 2017 |
| Title 20 (2015) | Standards for Fluorescent Lamp Ballasts and Replacement Fluorescent Lamp Ballasts (Table J-1) and Federally Regulated General Service Fluorescent Lamps (Tables K-1 and K-2) | July 1, 2015 |
| NEMA (2012) | Federal standards for general service fluorescent lamps issued by DOE | July 14, 2012 |

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

There were no non-DEER studies that were used in the development of this work paper.

## 1.6 Data Quality and Future Data Needs

No additional data needs are required.

# Section 2. Calculation Methodology

The following table indicates which DEER measures were used. Each measure code corresponds to two DEER MeasureIDs—one for non-residential and one for residential. One READI export was created for each sector. No modifications were made to the DEER values. All savings are in Attachment 1.

READI Data Used

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Code** | **Measure Name** | **MeasureID** | **READI Data** |
| LT-21844 | (1) 48in Reduced Wattage (28W) T8 Linear Fluorescent replacing (1) 48in T8 Linear Fluorescent (32W) | C-In-LFLmpBlst-T8-48in-28w+El-IS-NLO(27w)-dWP3-2 |  |
| R-In-LFLmpBlst-T8-48in-28w+El-IS-NLO(27w)-dWP3-2 |
| LT-97103 | (1) 48in Reduced Wattage (25W) T8 Linear Fluorescent replacing (1) 48in T8 Linear Fluorescent (32W) | C-In-LFLmpBlst-T8-48in-25w+El-IS-NLO(26w)-dWP4-2 |
| R-In-LFLmpBlst-T8-48in-25w+El-IS-NLO(26w)-dWP4-2 |

# 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 | DEER:Indoor\_Non-CFL\_Ltg | NON\_RES |
| Education - Community College |
| Education - Primary School |
| Education - Relocatable Classroom |
| Education - Secondary School |
| Education - University |
| Grocery |
| Health/Medical - Hospital |
| Health/Medical - Nursing Home |
| Lodging - Guest Rooms |
| Lodging - Hotel |
| Lodging - Motel |
| Manufacturing - Bio/Tech |
| Manufacturing - Light Industrial |
| Office - Large |
| Office - Small |
| Restaurant - Fast-Food |
| Restaurant - Sit-Down |
| Retail - Multistory Large |
| Retail - Single-Story Large |
| Retail - Small |
| Storage - Conditioned |
| Storage - Unconditioned |
| Warehouse - Refrigerated |
| Residential Multi-family | DEER:Indoor\_Non-CFL\_Ltg | RES |

# Section 4. Costs

CostIDs and equipment costs are from DEER. Labor cost is from WO017. In WO017, the labor cost for a linear fluorescent lamp and ballast is 2.39 hours at an hourly rate of $72.55/hour, totaling $173.10. There were no miscellaneous costs involved. [see Attachment 2]

## 4.1 Base Case Cost

The two measures share the same base case.

**Base Case Cost**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **DEER CostID** | **Description** | **Equipment Cost** | **Labor + Misc Cost** |
| LT-21844, LT-97103 | LFLmpBlst-T8-48in-32w-1g+El-IS-NLO-3(30w) | LF lamp and ballast: LF lamp: T8, 48 inch, 32W, 2710 lm, CRI = 75, rated life = 15000 hours (1): LF Ballast: Electronic, Instant Start, Normal LO (0.5); Total Watts = 30 | $13.69 | $173.10 |

## 4.2 Measure Case Cost

**Measure Case Cost**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Measure Code** | **DEER CostID** | **Description** | **Equipment Cost** | **Labor + Misc Cost** |
| LT-21844 | LFLmpBlst-T8-48in-28w+El-IS-NLO(27w) | LF lamp and ballast: LF lamp: T8, 48 inch, 28W, 2585 lm, CRI = 85, rated life = 24000 hours (1): LF Ballast: Electronic, Instant Start, Normal LO (0.5); Total Watts = 27 | $16.77 | $173.10 |
| LT-97103 | LFLmpBlst-T8-48in-25w+El-IS-NLO(26w) | LF lamp and ballast: LF lamp: T8, 48 inch, 25W, 2210 lm, CRI = 85, rated life = 24000 hours (1): LF Ballast: Electronic, Instant Start, Normal LO (1); Total Watts = 26 | $23.87 | $173.10 |

## 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 |

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-21844 | ROB | $3.08 | $3.08 | N/A |
| LT-97103 | ROB | $10.18 | $10.18 | N/A |

# Attachments

1. SCE17LG092.0 A1 – Calculation Template\_Final.xlsm
2. SCE17LG092.0 A2 – DEER Cost Screen Shots.xlsx

# References

1. References\_12122016\_100741.xlsx

[496]

[493]

[A] Southern California Edison 2016 Solutions Directory, pgs. 8-10

[B] NEMA New 2012 Standards for General Service Fluorescent Lamps (GSFL)