Work Paper SCE13LG092

**Revision 2**

**Southern California Edison**

**Fluorescent Lamp to Fluorescent Lamp**

**For Work Paper Reviewer Use Only**

**List all major comments that occurred during the review. This table may only be removed during management review.**

|  |  |  |  |
| --- | --- | --- | --- |
| **Major Comment** | **Reviewer Name** | **Date** | **Outcome/Resolution** |
| 47-51W eligibility | Yun | 9/30/15 | Added an eligibility requirement but did not change measure name because DEER is 49W. |
| Negative IMC | Yun | 9/30/15 | Negative IMC is a result of using DEER costs. I assumed that if DEER allows it, it’s OK. Unsure what SCE policy is. |
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|  |  |  |  |

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Measure Codes** | LT-21844, LT-97103, LT-69153 |
| **Measure Description** | 48in Reduced Wattage T8 Linear Fluorescent Lamp  46in Energy Saver T5 Linear Fluorescent Lamp |
| **Base Case Description** | 48in Standard Efficiency T8 Linear Fluorescent Lamp  46in Standard Efficiency T5 Linear Fluorescent Lamp |
| **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 | 5/15/12 | Neha Arora (SCE) | Updated to latest work paper template v0.1 from WPSCNRLG0092 including Interactive Effects, Codes/Standards or Update Base Case, NTG, EUL, Cost, and Dual Baselines. |
| 1 | 3/05/14 | Andrew Nishida (Lincus, Inc.) | Updated to the 2013 Title 24 Requirements and ED Lighting Disposition.  Work paper updated for reporting period, effective 7/1/2014 – 12/31/2014. |
| 2 | 9/16/15 | Jason Wang (SCE) | * Updated with DEER2016 values. * Updated requirements from SCE Solutions Directory. * Updated equipment costs with DEER values, and labor costs with WO017 values. * Updated Title 20 reference to 2015 version. |

# 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  Energy Saver T5 linear fluorescent lamp: 49W |
| 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) |
|  |  | LT-69153 |  | (1) 46in (1) Instant Start Ballast - Normal Light Output - Energy Saver T5 Linear Fluorescent (49W) replacing (1) 46in T5 Linear Fluorescent (54W) |

**Eligibility Requirements**

* T5 lamps from 47-51W are eligible for measure code LT-69153.

**Requirements from the 2013-2015 Solutions Directory**

General Lighting Eligibility [A]

* All new lighting fixtures, retrofit kits, and components must carry the appropriate, designated Underwriters Laboratory (UL) or Edison 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 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 2013-2015 Solutions Directory Lamp and Ballast requirement table.
* Manufacturer’s specification sheets for lamps and ballasts must be provided.

## 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, Partnerships, Multi-Family Energy Efficiency Rebate, 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

**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 |
| New Construction (NEW/NC) | 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 |
| Retrofit First Baseline Only (REF) | Above Customer Existing | N/A | EUL | N/A |
| Retrofit Add-on (REA) | Above Customer Existing | 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** |
| Appliance Turn-in and Recycling | The program motivates customers, through financial incentives, to recycle appliances that are functional but inefficient. This prevents the continued use of those appliances, by both the current owner and potential future owners. |
| Audit/Information/Testing Services | The program performs a free assessment of a customer’s facility and provides the customer with information and guidance on energy efficiency opportunities. |
| Commissioning and Retrocommissioning | The program modifies or repairs existing equipment to ensure that it works as intended. |
| Financial Support | The program motivates customers, through financial incentives such as rebates or low interest loans, to implement energy efficient measures or projects. |
| Innovative Design | The program funds new ideas that meet reasonable scientific scrutiny for potential energy savings. These innovative measures typically have small market penetration (less than 5%) or are targeted toward relatively unreached market segments. |
| New Construction | The program offers financial incentives and/or design assistance to customers involved with new building construction. This is intended is to motivate customer to exceed Title 24 building energy efficiency requirements (residential or nonresidential). |
| Partnership | The program implements projects through a partnership between the utility and an institutional, government, or community-based organization. |
| Performance Based | The program offers financial incentives that vary based on the energy efficiency performance of specific projects. |
| Up-Stream Programs | See Up-Stream Incentive and Up-Stream Buy Down in the Incentive Method 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 | The program gives a financial incentive to a midstream market actor, such as a retailer or contractor, to encourage the promotion of efficient measures. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Incentive | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, to encourage the manufacture, provision, or distribution of an efficient measure. The incentive may or may not be passed on to the end-use customer. |
| Up-Stream Buy Down | The program gives a financial incentive to an upstream market actor, such as a manufacturer or distributor, with specific requirements to pass down the incentive to the end use customer. Such an incentive buys-down the cost of an efficient measure for the end-use customer by at least the amount of the financial incentive. |
| Giveaway | The program provides customers with energy efficiency equipment or services for free. |
| Exchange/Replacement | The utility program holds events where customers can trade functional equipment for similar but more energy efficient equipment, free of charge. |
| On-bill Finance/Loan | The program offers financing for the cost an efficient measure as part of the utility bill. This can be an add-on option to an existing program or can serve as an organizing principle for its own program. |

## 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 2016, READI v2.3.0 |
| 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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **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 “Lighting System Alterations” are regulated by Standards Table 141.0-E of California’s Title 24 2013 Building Energy Efficiency Standards [355]. The measures addressed in this work paper fall under the Title 24 Standards for “Lighting System Alterations”.

*“Lighting System Alterations include alterations where an existing lighting system is modified,*

*luminaires are replaced, or luminaires are disconnected from the circuit, removed and*

*reinstalled, whether in the same location or installed elsewhere.*

*EXCEPTION 1 to Section 141.0(b)2Iii: Alterations that qualify as a Luminaire Modification-in-Place.”*

The exception to this standard is the case of alteration qualifying as a “Luminaire Modification-in-Place”. The measures addressed in this work paper do not qualify as a “Luminaire Modification-in-Place” because it violates the following Standard listed in Title 24:

“*To qualify as a Luminaire Modification-in-Place, luminaires shall only be modified by one or*

*more of the following methods:*

1. *Replacing lamps and ballasts with like type or quantity in a manner that preserves the*

*original luminaire listing.”*

Since the measures addressed are to change out the lamp for a reduced wattage lamp, and not the respective ballast, they do not qualify as “Luminaire Modification-in-Place”, thus must comply with Table 141.E in Title 24, and a lighting power density (LPD) analysis must be performed in this situation. 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 (2013) | 2013 Building Efficiency Standards, Table 140.6-C and Table 141.0-E | July 1, 2014 |
| 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 |
| LT-69153 | (1) 46in (1) Instant Start Ballast - Normal Light Output - Energy Saver T5 Linear Fluorescent (49W) replacing (1) 46in T5 Linear Fluorescent (54W) | C-In-LFLmpBlst-T5-46in-49w+El-IS-NLO(49.3w)-dWP4 |
| R-In-LFLmpBlst-T5-46in-49w+El-IS-NLO(49.3w)-dWP4 |

# 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 |

# 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.

## 4.1 Base Case Cost

The two measures share the same base case.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **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 | $24.73 | $173.10 |
| LT-69153 | LFLmpBlst-T5-46in-54w+El-IS-NLO(54w) | LF lamp and ballast: LF lamp: T5, 46 inch, 54W, 4750 lm, CRI = 85, rated life = 25000 hours (1): LF Ballast: Electronic, Instant Start, Normal LO (1); Total Watts = 54 | $30.66 | $173.10 |

## 4.2 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 | $27.16 | $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 | $23.86 | $173.10 |
| LT-69153 | LFLmpBlst-T5-46in-49w+El-IS-NLO(49.3w) | LF lamp and ballast: LF lamp: T5, 46 inch, 49W, 4150 lm, CRI = 85, rated life = 25000 hours (1): LF Ballast: Electronic, Instant Start, Normal LO (1); Total Watts = 49.3 | $29.63 | $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 |
| NEW/NC |
| RET/ER | (MEC + MLC) – (BEC + BLC) | MEC + MLC | (MEC + MLC) – (BEC + BLC) |
| REF | (MEC + MLC) – (BEC + BLC) | MEC + MLC | N/A |
| REA | MEC + MLC | MEC + MLC | 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 | $2.43 | $2.43 | N/A |
| LT-97103 | ROB | -$0.87 | -$0.87 | N/A |
| LT-69153 | ROB | $-1.03 | -$1.03 | N/A |

Note that some incremental costs are negative according to DEER.

# Attachments

1. 

# References



[355]

[493]

[A] Southern California Edison 2013-2015 Solutions Directory, pgs. 6-7

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