**Work Paper WPSDGENRLG0044**

**Revision 4**

**San Diego Gas & Electric**

**Energy Efficiency Engineering**

**Interior Linear Fluorescent Fixture**

**Measure Codes: L-H11 thru L-H61**

### Core Measure Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | | | | | PT | | 1st Baseline Period | | | | 2nd Baseline Period | | | | TOU |
| Measure Name | Measure RunID | Solution Code | CZ | Building Type | Load Shape | EUL | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | Gross Unit Annual Electricity Savings (kWh/unit) | User Entered kW Savings per unit (kW/unit) | Gas Savings (Therms) | 1st Baseline Useful Life | kWh Saving per unit (kWh/unit) | kW Savings per unit (kW/unit) | Gas Savings (Therms) | 2nd Baseline Useful Life | % TOU |
| **Refer to workpaper WPSDGENRLG0999** |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Note: **See WPSDGENRLG0999 for detailed savings**

### Costing and NTG Summary Table

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| General Measure Information | | | | PT | | NTG | | | IR | 1st Baseline Period | 2nd Baseline Period | IMC | DIM |
| Measure Name | Solution Code | CZ | Unit Definition | Program Type (NEW, ROB, RET) | Applicable Code | NTG Non-Res. | NTG Res. | NTG Multi Family | NTG Non-Res. | Gross Measure Cost per unit | Gross Measure Cost per unit | Incremental Measure Cost per unit | Delivery & Incentive Method |
| **Refer to workpaper WPSDGENRLG0999** |  |  |  |  |  |  |  |  |  |  |  |  |  |
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Note: **See WPSDGENRLG0999 for the complete list of Measures**

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | MM/DD/YY | Author/Affiliation | Summary of Changes |
| 0 | 12/2003 | PGE | Short version |
| 1 | 09/10/2009 | Lucie Sidibe, SDG&E | Linear Fluorescent Interior Fixture SDGEWPNRL044 adopted from PGE Work Paper Revision0, April 01, 2008, PGECOLTG114 |
| 2 | 08/12/2011 | Charles Harmstead, SDG&E | * Updated NTG value to DEER08 * Updated Cost values * Saving calculations were adjusted to meet DEER 3.02 Lighting Work Book hours and interactive effects. Dual baselines were added, where applicable |
| 3 | 06/26/2012 | Charles Harmstead, SDG&E | * Updated NTGR value to DEER 2011 * Updated savings calculations to workpaper WPSDGENRLG0999 |
| 4 | 01/30/2014 | Rocaciano Vega, RMS | * Updated workpaper to new format. * Added Measures table, DEER Difference Summary table, Code Summary table, GSIA ID table, and Building Types and Load Shapes table. * Updated Code Analysis, Measure EUL, NTG, and Energy Savings & Demand Reduction Calculations, and Costs sections per the CPUC Lighting Disposition (Nov. 12, 2013) * Referenced workpaper WPSDGENRLG0999, where applicable. |

# Section 1. General Measure & Baseline Data

## Measure & Delivery Description

### 1.1a Measure Description

Only complete new T8 or T5 or High Output (HO) T5 fixtures qualify. New fixtures must not exceed the maximum wattage listed in Table 1 below for each range of lamp wattage being replaced and must have a lower wattage than the new fixture. (Note: In all cases, the wattage of the replacement fixture must be less than the wattage of the existing lamp. The maximum replacement wattage listed in the table for each category is typically associated with the highest wattage in the base case range.) Fixtures must be equipped with linear fluorescent lamps and ballasts that meet the specifications defined in the T8 or T5 Linear Fluorescent Lamps with Electronic Ballasts category. New fixtures must replace one-for-one, existing Incandescent, Mercury Vapor, T12/High Output Fluorescent, T12/Very High Output Fluorescent, Standard Metal Halide, or High Pressure Sodium Fixtures in interior installations.

Table 1 Measure Names

|  |  |
| --- | --- |
| Product Code | Measure name |
| L-H11 | Up to 600 Watt Interior Fixture T5 Linear Fluorescent replacing greater than 400 Watt lamp base case |
| L-H21 | Up to 244 Watt (Tier 1) Interior Fixture T5 Linear Fluorescent replacing 400 Watt lamp base case |
| L-H31 | 245 to 360 Watt (Tier 2) Interior Fixture T5 Linear Fluorescent replacing 400 Watt lamp base case |
| L-H41 | Up to 192 Watt Interior Fixture T5 Linear Fluorescent replacing 176 - 399 Watt lamp base case |
| L-H51 | Up to 128 Watt Interior Fixture T5 Linear Fluorescent replacing 101 - 175 Watt lamp base case |
| L-H61 | Up to 64 Watt Interior Fixture T5 Linear Fluorescent replacing less than 100 Watt lamp base case |

### 1.1b Delivery and Incentive Mechanism

The delivery method that is available for these measures are

* Financial Support - Down-Stream Incentive – Deemed, in which the rebate is paid directly to the customer
* Financial Support – Direct Install, in which the measure is installed at the customer’s facility by program contractors.

The install types are:

* Retrofit (RET) for direct install.
* Replace-on-Burnout (ROB)

### 1.1c Measure Requirements

Existing Pulse Start Metal Halide installations do not qualify. Exterior installations do not qualify. All fixtures must be hardwired. Fixtures are not eligible for additional rebates under the Compact Fluorescent Fixtures and T8 or T5 Linear Fluorescent Lamps with Electronic Ballasts categories, but may qualify for an occupancy sensor rebate under the Occupancy Sensor category, provided all requirements are met. To qualify for the 400 Watt and >400 Watt categories, fixtures must be installed at a height over 12’ above the finished floor.

## 1.2 DEER Differences Analysis

DEER 3.02 Interactive Effects Lighting Workbook will be used to determine energy savings, demand reductions and therm offsets.

Non-CFL operating hours will be used. Based on the new operating hours, building types, weather zones, and the interactive effects, the energy savings is calculated (SDG&E calculations); The NTG, and other values used in this work paper are from DEER 2008.

Table 2 DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | No |
| Deviation from DEER | DEER does not contain this type of measure. |
| DEER Version | N/A |
| DEER Run ID and Measure Name | N/A |

## 1.3 Code Analysis

## In Section 149(b) of California’s Title 24 2008 [65] Non-Residential Building Energy Efficiency Standards, the Alteration codes and standards language states:

## Alterations to existing indoor lighting systems shall meet the following requirements:

## Alterations that increase the connected lighting load, replace, or remove and re-install a total of 50 percent or more of the luminaries in an enclosed space, shall meet the requirements of Sections 130 and 146; and

## The following wiring alterations shall meet the requirements of Sections 119, 131, and 134:

## Where new or moved wiring is being installed to serve added or moved luminaries; or

## Where conductor wiring from the panel or from a light switch to the luminaries is being replaced, or

## Where a lighting panel is installed or relocated.

## For an alteration where an existing enclosed space is subdivided into two or more spaces, the new enclosed spaces shall meet the requirements of Sections 131(a) and (d); and

4. Alterations that have less than 0.5 watts per square foot and increase the existing lighting power density to 0.5 watts per square foot or greater shall meet the requirements of Sections 119, 130, 131, 134,143(c), and 146.

Title 20 Appliance Efficiency Regulations include an Energy Efficiency Standard for Metal Halide Luminaires. Probe-start ballasts metal halide luminaires rated at least partially within the range of 150 to 500 watts are not eligible. Additionally, metal halide luminaires that are not probe-start ballasts must comply with Section 1605.3(n)(2)(A) and 1605.3(n)(2)(B) as applicable.

Effective July 14th, 2012, multiple T12 lamp types will be impacted by the new US Department of Energy standards set for general service fluorescent lamps. Accordingly, T12 fixtures are being phased out as an eligible baseline lighting technology for the purpose of calculating energy savings for lighting retrofit projects. In accordance with this requirement, all T12 fixtures are not eligible as Base Case for this measure.

Table 3 Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 24 (2008) | 2008 Non-Residential Compliance Manual, Sections 130 and 146 | January 1, 2010 |
| Title 20 (2010) | Section 1605.3(n) Energy Efficiency Standard for Metal Halide Luminaires | January 1, 2010 |

## 1.4 Measure Effective Useful Life

According to Federal requirements, Measure codes L-H11, L-H51, and L-H61 measure life will not be affected by dual baseline. Measure Codes L-H21, L-H31, and L-H41 will be affected by dual baseline, with RUL of 5 years (evaluated with existing lamps as baseline) and (EUL- RUL) of 10 years (evaluated at current code baseline). Hours of operation are provided in the DEER 3.02 Work Book.

DEER11 and the CPUC ED Workpaper Disposition for Lighting Retrofits documentation provides EUL and RUL information to be used for the 13-14 program cycle on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “Summary of EUL-RUL Analysis for the April 2008 Update to DEER” provides the RUL value as a flat 1/3 of the EUL value. The RUL value will only be applied to the first baseline period for retrofit measures that have applicable code that will affect the energy savings. In all other installation types and retrofit with no applicable code that affects the energy savings, the RUL is not applicable to either the first or second baseline period.

To obtain the EUL value, the CPUC ED Workpaper Disposition for Lighting Retrofits documentation issued on November 12, 2013, “2013-2014\_LightingRetrofit\_Disposition-12November2013.xlsx” [A], was consulted. The disposition workbook specifies 70,000 hours for the non-residential linear fluorescent T8 lamp technology. Please consult workpaper WPSDGENRLG0999 [B] for the actual EUL values used for all of the building types in this workpaper.

The EUL ID used in this workpaper is “ILtg-Lfluor-Elec” with a Sector ID of “Com”.

Table 4 DEER08 EUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Market | Enduse | EUL ID | Measure | EUL (Years) | RUL (Years) |
| Non-Residential | Indoor Lighting | ILtg-Lfluor-Elec | Linear Fluorescents | EUL varies by building type  EUL = Rated Life of Ballast (70,000 hours) / Annual usage for building type (usage provided by DEER) OR  15 years (whichever is less). | RUL value is a flat 1/3 of the EUL value |

## 1.5 Net-to-Gross Ratios for Different Program Strategies

The NTG value was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” on the DEER website as required by Version 4 of the California Public Utilities Commission (CPUC) Energy Efficiency Policy Manual [132], and the CPUC ED Workpaper Disposition for Lighting Retrofits documentation issued on November 12, 2013, “2013-2014\_LightingRetrofit\_Disposition-12November2013.xlsx” [A]. The relevant NTGR for this measure is shown in Table 6 below.

Table 5 Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID\* | NTG\* |
| NonRes-sAll-mT5T8-dn | T5 and T8 lamps | Com | Any | PreRebDown | 0.7 |
| Com-Default>2yrs | T8 lamps\*\* | Com | Any | All | 0.6 |

\*Denotes that the column is taken from the DEER NTG Table.

\*\*This Measure value is also applied to T5 fixtures.

The installation rate (IR) is identified in the calculation attachment. This value is obtained from a spreadsheet created by the DEER team titled “GrossSavingsAdjustments.xlsx” and the CPUC ED Workpaper Disposition for Lighting Retrofits documentation issued on November 12, 2013, “2013-2014\_LightingRetrofit\_Disposition-12November2013.xlsx” [A]. The installation rate varies by end use, sector, technology, application, and delivery method. Refer to workpaper WPSDGENRLG0999 for specific GSIA values used.

Table 6 Gross Savings Installation Adjustment (GSIA) IDs

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID | Description | Sector | BldgType | UseCategory | TechType |
| Com-LF-SDG | Non-Res Linear Fluorescent fixture; Annual Installation Rate | Com | Any | Lighting | LinFluor\_fixt |

## Spillage rate will also be applied to measures however the values will not be tracked in the workpapers. The spillage rate will be tracked in an external table to be supplied to the Energy Division.

## 1.6 Time-of-Use Adjustment Factor

As directed by the CPUC in decision 06-06-063 dated June 29, 2006, time-of-use (TOU) adjustment factors are to be applied for 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.

Table 7 TOU Summary Table

|  |  |
| --- | --- |
| Measure | % |
| Linear Fluorescent Fixtures | 0 |

# 

# Section 2. Energy Savings & Demand Reduction Calculations

# The energy savings (ΔWatts) is the difference in wattage from the base case to the measure case as shown below. Assumed Wattage for both measure and base cases were taken for the SDGE Standard Performance Contract (SPC) Table of Standard Fixture Wattages Appendix B [C]. Table 8 provides a summary of the measure and delta wattages used in the demand reduction calculation methodology, as described in the CPUC ED Workpaper Disposition for Lighting Retrofits documentation issued on November 12, 2013 [A ]. Refer to workpaper WPSDGENRLG0999 [B] for the detailed lighting calculations.

*ΔWatts = Base Case Wattage – Measure Case Wattage*

Equation 1illustrates the energy savings estimation methodologies used to calculate Non-CFL interior lighting measures.

  Equation 1

Equation 2 illustrates the peak demand reduction estimation method used. Refer to workpaper WPSDGENRLG0999 [B] for the detailed lighting calculations.

 Equation 2

Table 8 Measure Wattage Summary

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Product Code | Description | Baseline Technology | Code Technology | Measure Technology | CstAve  Watts | Code Watt | Meas Watts | CstAve  Δ Watts | Code  Δ Watts |
| L-H11 | >400 Watt lamp base case, up to 600 Watt replacement fixture | HIDfixt-MH-458w | HIDfixt-MH-458w | LFFixt-T5-46in-54w-El-PS-HLO(585w) | 458 | 458 | 585 | -127 | -127 |
| L-H21 | 400 Watt lamp basecase, up to 244 Watt replacement fixture (Tier 1) | HIDfixt-MH-458w | HIDfixt-PSMH-400w | LFFixt-T5-46in-54w-El-PS-HLO(234w) | 458 | 400 | 234 | 224 | 166 |
| L-H31 | 400 Watt lamp basecase, 245 to 360 Watt replacement fixture (Tier 2) | HIDfixt-MH-458w | HIDfixt-MH-458w | LFFixt-T5-46in-54w-El-PS-HLO(351w) | 458 | 458 | 351 | 107 | 107 |
| L-H41 | 176-399 Watt lamp basecase, up to 192 Watt replacement fixture | HIDfixt-MH-295w | HIDfixt-PSMH-288w | LFFixt-T5-46in-54w-El-PS-HLO(179w) | 295 | 288 | 179 | 116 | 109 |
|  |  |  |  |  |  |  |  |  |  |
| L-H51 | 101-175 Watt lamp basecase, up to 128 Watt replacement fixture | HIDfixt-MH-190w | HIDfixt-MH-190w | LFFixt-T5-46in-54w-El-PS-HLO(117w) | 190 | 190 | 117 | 73 | 73 |
| L-H61 | ≤100 Watt lamp basecase, up to 64 Watt replacement fixture | HIDfixt-MH-95w | HIDfixt-MH-95w | LFFixt-T5-46in-54w-El-PS-HLO(62w) | 95 | 95 | 62 | 33 | 33 |

Equation 3 illustrates losses in Gas savings associated with these measures. Refer to workpaper WPSDGENRLG0999 [B] for the detailed lighting calculations.

**Equation 3**

# Section 3. Load Shapes

The difference between the base case load shape and the measure load shape would be the most appropriate load shape; however, only end-use profiles are available. Therefore, the closest load shape chosen for this measure is the DEER:Indoor\_Non-CFL\_Ltg load shape. See Table 10 for a list of all Building Types and Load Shapes. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

Table 9 Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Agricultural | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Assembly | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Primary School | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Secondary School | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Relocatable Classroom | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - Community College | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Education - University | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Grocery | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Food Store | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Health/Medical - Hospital | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Health/Medical - Nursing Home | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Health/Medical - Clinic | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Lodging - Hotel | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Lodging - Guest Rooms | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Lodging - Motel | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Manufacturing - Bio/Tech | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Manufacturing - Light Industrial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Industrial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Misc - Commercial | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Office - Large | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Office - Small | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Restaurant - Fast-Food | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Restaurant - Sit-Down | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Multistory Large | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Single-Story Large | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Retail - Small | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Storage - Conditioned | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Storage - Unconditioned | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |
| Transportation - Communication - Utilities | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |

# Section 4. Base Case & Measure Costs

## 4.1 Base Case Cost

The base case and code base case costs are taken from the DEER 2008 Cost Summary Spreadsheet [D]. See workpaper WPSDGENRLG0999 [C] for actual base case costs used in this workpaper.

**4umed Measure HO T5/T8 Replacement Wattage, Including Ballast**

## 4.2 Gross Measure Cost

The measure case costs are taken from the DEER 2008 Cost Summary Spreadsheet [D]. See workpaper WPSDGENRLG0999 [C] for actual gross measure costs used in this workpaper.

For RET (1st Baseline), the gross measure cost is the full measure cost:

GMC = (Measure Equipment Cost + Measure Labor Cost)

For RET (2nd Baseline), the gross measure cost is:

GMC = (Measure Equipment Cost – Code Equipment Cost)

For ROB, the equipment being replaced is assumed to have failed in place or is past its useful life. The customer is faced with either purchasing standard efficiency or code baseline equipment versus energy efficient equipment. Therefore, gross measure cost (GMC) means the cost premium required to install the energy efficient measure over a less efficient piece of equipment. GMC is represented by the equation below:

GMC = (Measure Equipment Cost + Measure Labor Cost) –

(Base Case Equipment Cost + Base Case Labor Cost)

= (Measure Equipment Cost – Code Equipment Cost)

\*Note: Unless stated otherwise the measure case labor and base case labor are assumed to be the same value. For this work paper, the measure and base case (code base case) costs are different.

## 4.3 Incremental Measure Cost

## For Measures L-H1, L-H5, and L-H6 Measure cost is incremental cost.

For Measures L-H2, L-H3, and L-H4 Measure costs are as follows: For RUL Measure cost is full cost of retrofit fluorescent fixture. For (EUL-RUL) Code baseline, Measure cost is Measure cost – Code Baseline. See workpaper WPSDGENRLG0999 [C] for actual incremental measure costs used in this workpaper.

# Attachments

1. 

# References



[31]

[65]

[132]

[A] CPUC ED Workpaper Disposition for Lighting Retrofits documentation issued on November 12, 2013, “2013-2014\_LightingRetrofit\_Disposition-12November2013.xlsx”

[B] SDG&E Workpaper WPSDGENRLG0999

[C] Attachment #1 - Appendix B: Table of Standard Fixture Wattages

[D] Attachment #2 – DEER08 Cost Values and Documentation

Lookup Table ID Summary

EUL

|  |  |  |
| --- | --- | --- |
| EUL\_ID | Description | Sector |
| ILtg-Lfluor-Elec | Linear Fluorescent with Electronic Ballast | Com |

NTGR

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID | Description | Sector | BldgType | ProgDelivID | NTG |
| NonRes-sAll-mT5T8-dn | T5 and T8 lamps | Com | Any | PreRebDown | 0.7 |
| Com-Default>2yrs | T5 & T8 lamps | Com | Any | All | 0.6 |

GSIA

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID | Description | Sector | BldgType | UseCategory | TechType |
| Com-LF-SDG | Non-Res Linear Fluorescent fixture; Annual Installation Rate | Com | Any | Lighting | LinFluor\_fixt |

BUILDING TYPE & LOAD SHAPE

|  |  |  |
| --- | --- | --- |
| Building Type | E3 Alt. Building Type | Load Shape |
| Any | NON\_RES | DEER:Indoor\_Non-CFL\_Ltg |