**Work Paper PGECOLTG178**

**LED High-Bay and Low-Bay Fixtures**

**Revision 2**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**LED High-Bay and Low-Bay Fixtures**

**Measure Codes LD101-109, LD111 – LLD113**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | LD101-109, LD111 – LLD113 |
| **Measure Description:** | LED High-Bay and Low-Bay Fixtures, various wattages. |
| **Energy Impact Common Units:** | Fixture. |
| **Base Case Description:** | Pulse Start Metal Halide Fixture, 175 – 1000 Watts, or 2nd generation Linear Fluorescent Fixture with VHLO ballast and 4, 6 or 8 F32T8 lamps.  Source: PG&E Calculations. |
| **Base Case Energy Consumption:** | Various. Refer to .xlsx file attached  Source: PG&E Calculations. |
| **Measure Energy Consumption:** | Various. Refer to .xlsx file attached  Source: PG&E Calculations. |
| **Energy Savings (Base Case – Measure):** | Various. Refer to .xlsx file attached  Source: PG&E Calculations. |
| **Costs Common Units:** | $ per fixture. |
| **Base Case Equipment Cost ($/fixture):** | Various. Refer to .xlsx file attached.  Source: Work Order 17 |
| **Measure Equipment Cost ($/fixture):** | Various. Refer to .xlsx file attached  Source: Navigant |
| **Gross Measure Cost ($/fixture)** | V Various. Refer to .xlsx file attached  Source: PG&E Calculations |
| **Measure Incremental Cost ($/fixture):** | Various. Refer to .xlsx file attached  Source: PG&E Calculations |
| **Effective Useful Life (years):** | 12 years, ILtg-Com-LED-50000hr  Source: 2016 DEER |
| **Program Type:** | ROB/NC. |
| **Net-to-Gross Ratios:** | NTG= 0.6, Com-Default>2yrs  Source: DEER 2016 |
| **Important Comments:** |  |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| Revision # | Date | Section by Section Description of Revisions | Author (Company) |
| Revision 0 | 11/4/2013 | PGECOLTG178 R0 LED High-Bay and Low-Bay Fixtures.doc  Original Workpaper | Author: Greg Barker (Energy Solutions)  Reviewer: Alina Zohrabian (PG&E) |
| Revision 1 | 5/27/14 | PGECOLTG178 R1 LED High-Bay and Low-Bay Fixtures.doc  Added DI values from (PGE3PLTG192-R0) and Applied new hours of operation and IE factors. For updated savings values, see file PGECOLTG178 R1.xlsx | Alina Zohrabian (PG&E) |
| Revision 2 | 1/1/2016 | Updated NTG, EUL, IE, CDF, GSIA, and hours of operation per DEER2016. Base case and measure costs have also been updated. | Linda Wan (PG&E)/Alina Zohrabian (PG&E)/Tai Voong (PG&E) |

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# Section 1. General Measure & Baseline Data

## 1.1 Product Measure Description & Background

***Catalog Description***

Light Emitting Diode (LED) High-Bay and Low-bay Fixtures

**Requirements:**

* Must be a one for one replacement
* Must replace a High-Intensity Discharge (HID) or a Linear Fluorescent Fixture with 4, 6 or 8 F32T8 lamp with VHLO Ballast (BF > 1.1) and specified lamp wattage. (Please refer to Table 1)
* Must be on the Design Lights Consortium (DLC) qualified product list
* Self-ballasted screw-based lamps do not qualify.
* Must meet the Minimum Fixture Lumens and Wattage Minimum and Maximums listed for the appropriate base case fixture in Table 1.

Table 1 - LED High-Bay and Low-Bay Fixtures Base and Measure Wattages

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Measure Description** | **Base Case Fixture** | **Base Case system wattage** | **Minimum Fixture Lumens** | **LED minimum wattage** | **LED Maximum**  **wattage** |
| LD101 | LED High/Low Bay: 40 to 131 watts, replacing 175W PS-MH | Pulse-Start MH 175 | 208 | 6,200 | 48 | 131 |
| LD102 | LED High/Low Bay: >131 to 160 watts, replacing 200W PS-MH | Pulse-Start MH 200 | 232 | 9,600 | > 131 | 160 |
| LD103 | LED High/Low Bay: >160 to 187 watts, replacing 250 W PS-MH | Pulse-Start MH 250 | 288 | 11,200 | > 160 | 187 |
| LD104 | LED High/Low Bay: >187 to 220 watts, replacing 320W PS-MH | Pulse-Start MH 320 | 365 | 12,900 | > 187 | 220 |
| LD105 | LED High/Low Bay: >220 to 262 watts, replacing 350W PS-MH | Pulse-Start MH 350 | 400 | 15,800 | > 220 | 262 |
| LD106 | LED High/Low Bay: >262 to 280 watts, replacing 400W PS-MH | Pulse-Start MH 400 | 456 | 21,600 | > 262 | 280 |
| LD107 | LED High/Low Bay: >280 to 320 watts, replacing 450W PS-MH | Pulse-Start MH 450 | 506 | 23,900 | > 280 | 320 |
| LD108 | LED High/Low Bay: >320 to 500 watts, replacing 750W PS-MH | Pulse-Start MH 750 | 818 | 32,300 | > 320 | 500 |
| LD109 | LED High/Low Bay: > 500 to 750 watts, replacing 1000W PS-MH | Pulse-Start MH 1000 | 1080 | 43,400 | > 500 | 750 |
| LD111 | LED High/Low Bay: 40 to 131 watts, Replacing T8 Fluorescent 2nd generation 4L VHLO | T8 Linear Fluorescent 2nd generation 4L VHLO | 151 | 6,200 | 48 | 131 |
| LD112 | LED High/Low Bay: >131 to 160 watts, Replacing T8 Fluorescent 2nd generation 6L VHLO | T8 Linear Fluorescent 2nd generation 6L VHLO | 226 | 9,600 | > 131 | 160 |
| LD113 | LED High/Low Bay: >160 to 220 watts, Replacing T8 Fluorescent 2nd generation 8L VHLO | T8 Linear Fluorescent 2nd generation 8L VHLO | 302 | 11,200 | > 160 | 220 |

***Program Restrictions and Guidelines***

This work paper details the replacement of existing Pulse Start Metal Halide HID or linear fluorescent fixtures with LED High-Bay fixtures. The delivery method is Downstream Programs for commercial customers.

The LED fixture or retrofit kit must replace high intensity discharge, incandescent, or linear fluorescent high bay light fixtures installed in the following applications:

* + **High-Bay Luminaires (Fixtures & Retrofit Kits)**
  + **Low-Bay Luminaires (Fixtures & Retrofit Kits)**
  + **High-Bay Aisle Luminaires (Fixtures)**

DLC requirements for the high-bay and low-bay categories include:

* 5-year warranty
* 35,000 hour L70 Lumen Maintenance
* ≥ 70 Color Rendering Index (CRI)
* ≥ 80 lumens / Watt
* ≤ 5700 Kelvin Correlated Color Temperature (CCT)
* ≥ 5,000 Lumen light output
* ≥ 30% of Lumen Output in the 20° - 50° zone (higher for Aisle Lighting)

|  |
| --- |
| **Downstream Market Channel** |
| * Must be on Design Lights Consortium Qualified Products List, in one of 5 categories:   + High-bay Fixtures for Commercial and Industrial Buildings   + Low-bay Fixtures for Commercial and Industrial Buildings   + High-bay Aisle Lighting   + Retrofit Kits for High-Bay Luminaires for Commercial and Industrial Buildings   + Retrofit Kits for Low-Bay Luminaires for Commercial and Industrial Buildings |

**Terms and Conditions:**

The customer must be a non-residential PG&E electric customer.

**Market Applicability:**

The customer must be a non-residential PG&E electric customer.

**Type of Transaction:**

The applicable types of transactions include Replace on Burnout. The rebate incentivizes the choice of energy efficient equipment over the base case equipment, which is a Pulse Start Metal Halide HID or T8 fixture.

Table 2 Delivery Method and Applicable Building Types

|  |  |  |
| --- | --- | --- |
| **Delivery Type** | **Applicable Building Types** | **Application Type** |
| Downstream & Direct Install | DEER Building Types | ROB, NC |

## 1.2 Product Technical Description

Light emitting diode (LED) sources have improved over the past decade making them an efficient and reliable lighting technology. Many LED products have successfully replaced other lighting sources and made their way into the market through continuous improvement and compete with more established sources across many applications.

High-bay fixtures have traditionally used HID sources: high-pressure sodium and metal halide predominantly. More recently, retrofitting these fixtures to linear fluorescent high-output systems (either T5/HO or F32T8 with VHLO ballasts) has been a popular energy-efficiency measure. Low-bay fixtures have traditionally used both linear fluorescent and HID sources. The traditional division between high-bay and low-bay has been mounting heights greater than or less than 20 feet.

Improvements in LED technology, particularly in heat-sinking for higher-wattage products, have made high-bay and low-bay LED fixtures feasible. These are fixtures with output of at least 5,000 lumens. Current DLC-listed LED products achieve output up to 82,893 lumens.

This workpaper makes no distinction between high-bay and low-bay fixtures. The DLC classifies a 5,000 lumen minimum for low-bay compared to 10,000 lumens for high-bay, which likely fits generally with the traditional mounting-height-based definitions, but the DLC category does not determine the measure code under this workpaper. LED fixtures under this workpaper are assigned a measure code according to wattage.

This workpaper describes the energy savings associated with their replacement of Pulse Start Metal Halide HID or linear fluorescent fixtures.

## 1.3 Measure Application Type

The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls*, defines the terms as follows:

Table 3 Measure Application Type[[1]](#endnote-1)

Identifies the measure application type in the Measure Implemenation table in DEER2011.

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| *ER* | *Early retirement* | *measure applied while existing equipment still viable, or retrofit of existing equipment* |
| *ROB* | *Replace on Burnout* | *measure applied when existing equipment fails or maintenance requires replacement* |
| *NC* | *New Construction* | *measure applied during construction design phase as an alternative to a code-compliant standard design* |

All the measures within this workpaper are ROB and NC.

## 1.4 Product Base Case and Measure Case Data

The base fixtures for this workpaper are chosen by the code equivalent of the most common fixtures, which are pulse start metal halide and 2nd generation linear fluorescent fixtures.

## 1.4.1 DEER Base Case and Measure Case Information

The Database for Energy Efficient Resources (DEER) 2016 does not address LED savings for high-bay and low-bay fixtures.

**Delta Wattage Assumption (ΔW)**

This workpaper includes both Pulse Start Metal Halide HID and 2nd generation linear fluorescent base cases. The most common base case Pulse Start Metal Halide HID lamp wattages for high- and low-bay fixtures are 175 W, 200 W, 250 W, 320 W, 350 W, 400 W, 450 W, 750 W, and 1000 W. The fixture wattages for these Pulse Start Metal Halide HID base cases are approximately 15% higher than the lamp wattages. The most common 2nd generation linear fluorescent base case configurations are 4-lamp and 6-lamp F32T8 with VHLO ballast-factor ballasts. These base cases are used in this workpaper.

The DOE Solid-State Lighting CALiPER Reports have examined 7 LED high-bay fixtures combined in application summary reports #13 and #16. Only two of the 7 fixtures met the DLC minimums for efficacy and output. Given the small population relative to the full DLC list of 418 products as of 10/1/2013, CALiPER reports were not used for determining equivalency. Wattage equivalency was based on the full list of DLC products.

**Hours of Operation**

The DEER 2016 hours of operation and interactive effects are used for savings calculations.

**Net-to-Gross Assumption**

The NTG values are from DEER 2016. The table below summarizes all applicable Net-to-Gross ratios for programs that may be used by this measure.

Table 4 - Net-to-Gross Ratios

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **NTGR ID** | **Description** | **Sector** | **BldgType** | **Delivery Method** | **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.

**Installation Rate**

The IR value was obtained using the DEER READI tool. The relevant IR value for these measures in this work paper is in the table below.

Table 5 Installation Rates

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **GSIA ID** | **Description** | **Sector** | **BldgType** | **ProgDelivID** | **GSIAValue** |
| Com-HiBay-PGE | Non-Res High-Bay; Annual Installation Rate | Com | Any | NonUpStrm | 0.92 |

**Effective Useful Life / Remaining Useful Life**

The rated life for these products is assumed to be 35,000 hours, the minimum DLC specification. Rated life for DLC-listed products varies between 35,000 hours and 303,000 hours. Since the EUL is dependent on the hours of operation, the EUL varies by building type.

The EUL is based on 35,000 hours rated fixture life divided by average annual hours of operation for each building type:

EUL = (DLC-Minimum Fixture Life (hours)) / (Average Operating Hours Per Year)

Table 6 Effective Useful Life/Remaining Useful Life

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **EUL ID** | **Description** | **Sector** | **UseCategory** | **EUL (Years)** | **RUL (Years)** |
| ILtg-Com-LED-50000hr | LED Fixture - Indoor – Commercial | Com | Lighting | 12 | 4 |

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

***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 measure case fixtures do not fall under Federal DOE or EPA Energy Regulations. As amended by EISA 2007, EPCA regulates metal halide lamp fixtures designed to be operated with lamps rated greater than or equal to 150 watts (W), but less than or equal to 500 W, by prescribing performance requirements for the metal halide ballasts used in those metal halide lamp fixtures.[[2]](#endnote-2) Both metal halide lamps and ballasts are energy-using components of metal halide lamp fixtures. For this MH lamp wattage range, metal halide lamp fixtures must contain the following:

1. a pulse-start metal halide ballast with a minimum ballast efficiency of 88 percent;
2. a magnetic probe-start ballast with a minimum ballast efficiency of 94 percent; or
3. a nonpulse-start electronic ballast with—
   1. a minimum ballast efficiency of 92 percent for wattages greater than 250 watts; and
   2. a minimum ballast efficiency of 90 percent for wattages less than or equal to 250 watts.

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

***1.4.3.1 CALiPER Application Summary Report 16[[3]](#endnote-3):***

A few of the conclusions that CALiPER reported in the most recent application summary report (#16) from tests of 5 LED high-bay fixtures:

* Two products tested significantly outperformed the benchmark products in terms of light output and efficacy
* Three products performed as claimed in product literature

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

The fixture performance in the high-bay and low-bay categories of the DLC list was analyzed to justify the wattage equivalency assumptions. The 418 fixtures in these categories were analyzed for equivalency to common base case fixtures.

Rather than compare the fixtures based solely on lumen output, the quantity of lumens in the 20° - 50° zone was also considered. Many Pulse Start Metal Halide HID and linear fluorescent fixtures commonly over-illuminate the area directly beneath the fixture (0° - 20°) simply because they lack the ability to direct light to where it is needed most further from nadir. Pulse Start Metal Halide HID and linear fluorescent sources may achieve a higher average illuminance than an LED source (and have a correspondingly higher lumen output), however they achieve similar minimum illuminance because the LED fixture may be able to do a better job of directing light out to the edges of the illuminated space.

This analysis compares fixtures based on the lumen output in the 20° - 50° range to ignore the hot spot of light that may appear directly under a fixture, and in recognition of the fact that customers are often happy with the light output of LED fixtures with lower light output than the Pulse Start Metal Halide HID or linear fluorescent fixtures replaced.

The lumens in the 20° - 50° range was calculated from the DLC list based on the measured light output of each fixture multiplied by the % of lumens in that range, labeled on the DLC spreadsheet at ZL-HBLB: 20-50 or ZL-HBA: 20-50. The lumen output for base case fixtures in the 20° - 50° range was calculated from the zonal lumen summary tables of manufacturer photometric reports. These values were corrected for lamp lumens and ballast factor based on industry standards for Pulse-Start Metal Halide Lamps and F32T8 2nd generation linear fluorescent lamps.

The LED products equivalent in lumen output in the 20° - 50° range to the base case fixtures were grouped as well as possible, given the limitation of varying LED fixture performance. The base cases for Pulse Start Metal Halide HID and 2nd generation linear fluorescent fixtures were compared separately to the group of DLC-approved fixtures that would best replace them based on photopic lumens in the 20° - 50° zones. Measure codes were created by setting maximum and minimum wattage and minimum fixture lumen output values. Product eligibility will be determined by comparing products to those 3 values as found in the DLC list.

# Section 2. Calculation Methods

This workpaper uses the most recent DLC List to choose the most appropriate base and measure case wattages. The base case wattages are chosen based on the 12 most common high-bay and low-bay fixture configurations, with Pulse-Start Metal Halide HID base cases combined with 2nd generation linear fluorescent base cases.

The measure wattages are selected based on the DLC list. The lumen output in the 20° - 50° range is basis for the division of LED products into appropriate measure codes.

Table 7 - LED High-Bay and Low-Bay Fixtures Base and Measure Wattages

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Base Case** | **Base Case Wattage** | **Measure Case Wattage Range** | **Delta Wattage** | **Minimum Fixture Lumens** |
| Pulse-Start MH 175 | 208 | 48 to ≤ 131 Watts | 77 | 6,200 |
| Pulse-Start MH 200 | 232 | > 131 to ≤ 160 Watts | 72 | 9,600 |
| Pulse-Start MH 250 | 288 | > 160 to ≤ 187 Watts | 101 | 11,200 |
| Pulse-Start MH 320 | 365 | > 187 to ≤ 220 Watts | 145 | 12,900 |
| Pulse-Start MH 350 | 400 | > 220 to ≤ 262 Watts | 138 | 15,800 |
| Pulse-Start MH 400 | 456 | > 262 to ≤ 280 Watts | 176 | 21,600 |
| Pulse-Start MH 450 | 506 | > 280 to ≤ 320 Watts | 186 | 23,900 |
| Pulse-Start MH 750 | 818 | > 320 to ≤ 500 Watts | 318 | 32,300 |
| Pulse-Start MH 1000 | 1080 | > 500 to ≤ 750 Watts | 330 | 43,400 |
| T8 Linear Fluorescent 2nd generation 4L VHLO | 151 | 48 to ≤ 131 Watts | 20 | 6,200 |
| T8 Linear Fluorescent 2nd generation 6L VHLO | 226 | > 131 to ≤ 160 Watts | 66 | 9,600 |
| T8 Linear Fluorescent 2nd generation 8L VHLO | 302 | > 160 to ≤ 220 Watts | 82 | 11,200 |

## 2.1 Electric Energy Savings Estimation Methodologies

The lighting wattage difference (Watts per unit) is the difference between the electric demand of the base case unit and the electric demand of the measure case unit. The hours of operation and interactive effects are from DEER 2016.

**∆Watts/fixture:** The demand difference (watts per fixture) is simply the difference between the electric demand of the base case fixture and the electric demand of the measure case fixture.

∆Watts/fixture = Base Case Watts/fixture - Measure Case Watts/fixture

**Example:**

∆Watts/fixture = 208 W – 131 W = 77 ∆Watts/fixture

**Annual Electric Savings:**

Annual Energy Savings [kWh/fixture] = (∆Watts/fixture) x (Annual Hours of Operation) x (Energy Interactive Effects) / (1,000 Watts / kW)

**For LD101 LED High/Low Bay: 40 to 131 watts, replacing 175W PS-MH, ASM Building Type, ROB:**

Annual Energy Savings [130 kWh/fixture] = (208-131 Watts) x (1620 hrs/yr) x (1.04) / (1,000 Watts / kW)

## 2.2. Demand Reduction Estimation Methodologies

This measure includes HVAC interactive effects savings. This measure is not an Early Retirement measure.

**Demand Reduction:**

Demand Reduction [kW/fixture] = (∆Watts/fixture) x (Lighting Coincident Demand) x (Demand Interactive Effects) / (1,000 Watts/kW)

**For LD101 LED High/Low Bay: 40 to 131 watts, replacing 175W PS-MH, ASM Building Type, ROB:**

Demand Reduction [0.043 kW/fixture] = (208-131 Watts) x (0.48) x (1.17) / (1,000 Watts/kW)

## 2.3. Gas Energy Savings Estimation Methodologies

Gas estimates are entirely based on the estimated increased gas use through calculated interactive effects. This measure includes HVAC interactive effects impacts. This measure is not an Early Retirement measure.

**Annual Gas Savings:**

Annual Gas Savings [∆Therms/fixture] = (∆Watts/fixture) x (Annual Hours of Operation) x (Gas Interactive Effects) / 1,000 Watts/kW

**For LD101 LED High/Low Bay: 40 to 131 watts, replacing 175W PS-MH, ASM Building Type, ROB:**

Annual Gas Savings [-1.30 Therms/fixture] = (208-131 Watts) x (1620 hrs/yr) x (-0.0104) / 1,000 Watts/kW

# Section 3. Load Shapes

Load Shapes are an important part of the life-cycle cost analysis of any energy efficiency program portfolio. The net benefits associated with a measure are based on the amount of energy saved and the avoided cost per unit of energy saved. For electricity, the avoided cost varies hourly over an entire year. Thus, the net benefits calculation for a measure requires both the total annual energy savings (kWh) of the measure and the distribution of that savings over the year. The distribution of savings over the year is represented by the measure’s load shape. The measure’s load shape indicates what fraction of annual energy savings occurs in each time period of the year. An hourly load shape indicates what fraction of annual savings occurs for each hour of the year. A Time-of-Use (TOU) load shape indicates what fraction occurs within five or six broad time-of-use periods, typically defined by a specific utility rate tariff. Formally, a load shape is a set of fractions summing to unity, one fraction for each hour or for each TOU period. Multiplying the measure load shape with the hourly avoided cost stream determines the average avoided cost per kWh for use in the life cycle cost analysis that determines a measure’s Total Resource Cost (TRC) benefit.

## 3.1 Base Case Load Shapes

The closest load shape chosen for this measure is the “PGE:DEER:Com:Indoor\_Non-CFL\_Ltg” load shape.

## 3.2 Measure Load Shapes

The measure load shape for this measure is determined based on the applicable non-residential market sector and the lighting end-use.

The closest load shape chosen for this measure is the PGE:DEER:Com:Indoor\_Non-CFL\_Ltg load shape. See the KEMA report [31] for a more thorough discussion regarding the load shapes for this measure.

# Section 4. Base Case & Measure Costs

A joint effort was made between SCE and PG&E to update base case and measure costs for DEER 2016 affected measures. Please refer to the cost spreadsheet for detailed information

## 4.1 Base Case Costs

Base case equipment and labor costs were calculated using WO017[[4]](#endnote-4). The labor cost for these measures are $187.14.

## 4.2 Measure Costs

The measure equipment costs were taken from the Navigant report, and the labor cost is the same as the base case labor cost.

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **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

Please refer to the cost spreadsheet for detailed full and incremental cost information. Labor costs were not considered in the incremental costs since it is the same value.

# References:

1. The DEER Measure Cost Data Users Guide found on [www.deeresources.com](http://www.deeresources.com) under *DEER2011 Database Format* hyperlink, DEER2011 for 13-14, spreadsheet *SPTdata\_format-V0.97.xls.* [↑](#endnote-ref-1)
2. Notice Of Proposed Rulemaking Technical Support Document: Energy Efficiency Program For Consumer Products And Certain Commercial And Industrial Equipment: Metal Halide Lamp Fixtures. DOE. August 2013. [↑](#endnote-ref-2)
3. CALiPER Summary Report Round 13. DOE. October 2011. [↑](#endnote-ref-3)
4. 2010-2012 WO017 Ex Ante Measure Cost Study Final Report. Submitted by: Itron, Inc. May 27, 2014. Table 4-6. Page 4-12. *HID to T5 Fixtures high bay, lift accessible.* [↑](#endnote-ref-4)