**Work Paper PGE3PHVC159**

**Duct Test & Seal: Residential**

**Revision # 2**

**Pacific Gas & Electric Company**

**Customer Energy Solutions**

**Duct Test & Seal: Residential**

**Measure Code: H768, HV286**

# At-a-Glance Summary

|  |  |
| --- | --- |
| **Applicable Measure Codes:** | H768, HV286 |
| **Measure Description:** | Duct Test and Seal for residential, air-cooled, direct expansion, air conditioner and heat pump units. |
| **Energy Impact Common Units:** | kW, kWh and Therms Per Household |
| **Base Case Description:** | Source: DEER2015 READi (Version 2.1.0)  Duct leakage greater than 15% of system airflow. |
| **Base Case Energy Consumption:** | Source: DEER2015 READi (Version 2.1.0))  Varies based on climate zones and building types |
| **Measure Energy Consumption:** | Source: DEER2015 READi (Version 2.1.0)  Varies based on climate zones and building types |
| **Energy Savings**  **(Base Case – Measure):** | Source: DEER2015 READi (Version 2.1.0)  Varies based on climate zones and building types |
| **Costs Common Units:** | $ per Household |
| **Base Case Equipment Cost ($/unit):** | $0 |
| **Measure Equipment Cost ($/unit):** | Source: 2010-2012 WO017 Ex-Ante Measure Cost Study  $30.62 for Mobile Homes  $71.45 for Single family and Multifamily |
| **Gross Measure Cost ($/unit)** | Source: 2010-2012 WO017 Ex-Ante Measure Cost Study  $30.62 for Mobile Homes  $71.45 for Single family and Multifamily |
| **Measure Incremental Cost ($/unit):** | Source: 2010-2012 WO017 Ex-Ante Measure Cost Study  $109.16 for Mobile Homes  $252.69 for Single family and Multifamily |
| **Effective Useful Life (years):** | Source: DEER2014  18 years EUL and 6 years RUL |
| **Measure Application Type:** | Retro-Commissioning (RC) |
| **Net-to-Gross Ratios:** | 0.78  Source: DEER 2011\_NTGR\_2012-05-16 |
| **Important Comments:** |  |

## Work Paper Approvals

The following Manager(s) approved this work paper through the PG&E Electronic Data Routing System under Routing Requisition # \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

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| --- |
|  |
| **Grant Brohard**  Manager, Engineering Services  (Technical Product Support) |
| **Carolyn Weiner**  Manager, Core Products |

# Document Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision #** | **Revision**  **Date** | **Section-by-Section Description of Revisions** | **Author (Company)** |
| Revision 0 | 06/01/2012 | Update DEER2011 | Tai Voong (PG&E) |
| Revision 0 | 08/28/2012 | At-A-Glance Measure List: Changed Building Vintage. | Tai Voong (PG&E) |
| Revision 1 | 04/23/2014 | * Update savings based on DEER2015 READi Tool. * Update ISR to reflect new recommended ISR from the May 16, 2013 ED disposition. | Chris Li (PG&E) |
| Revision 2 | 3/9/15 | * Add new high leakage reduction measure (35/40% to 15/12%) * Use WO017 for cost | Chris Li (PG&E) |

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# Section 1. General Measure and Baseline Data

## 1.1 Product Measure Description & Background

Table 1: Base and Measure Cases

|  |  |
| --- | --- |
| **Typical Base Case Description from DEER** | Base case description for High Duct Leakage:   * 40% (20% Supply/20% Return) Leakage (single- and multi-family) * 35% Supply Leakage (mobile home)   Base case description for Medium Duct Leakage:   * 24% (12% Supply/12% Return) Leakage (single- and multi-family) * 25% Supply Leakage (mobile home) |
| **Typical Measure Description**  **From DEER** | Measure case description for High Duct Leakage Reduction:   * Residential: Duct Sealing (Total Leakage Reduced from High (35/40%) to Low (15/12%)   *(35% to 15% for mobile home and 40% to 12% for single- and multi- family)*  Measure case description for Medium Duct Leakage Reduction:   * Residential: Duct Sealing (Total Leakage Reduced from High (25/24%) to Low (15/12%)   *(25% to 15% for mobile home and 24% to 12% for single- and multi- family)* |

The following air conditioners, heat pumps, and furnaces are eligible under the Upstream HVAC program for residential customers:

Table 2: Measure Names

|  |  |  |  |
| --- | --- | --- | --- |
| PG&E Measure Codes | SCG / SDG&E Codes | SCE Solution Code | Measure name |
| HV286 |  |  | Residential: Duct Sealing (Total Leakage Reduced from (35/40%) to (15/12%)) |
| H768 |  |  | Residential: Duct Sealing (Total Leakage Reduced from (25/24%) to (15/12%)) |

## Catalog Description –

The measures presented on this work paper are not in the rebate catalog, they are promoted under our midstream HVAC program. The Duct Test and Seal Programs for residential mobile homes, multi-family homes, and single family homes are part of a comprehensive direct-install approach. Up to two duct tests are conducted; the first or “Test-in” is a system check to determine whether the unit’s duct system tightness meets the California Title 24 specifications. If the first check shows that duct tightness exceeds minimum tightness specifications, and the technicians correct the situation, a second test or “Test-out” is conducted to verify proper duct tightness was achieved. The Test-out procedure has assigned energy savings, whereas the “Test-in” procedure has no energy savings.

##### Program Restrictions and Guidelines

This product is part of the direct install program and the incentives are provided to the third party implementer and HVAC contractors. Measures are applied to any residential building throughout PG&E territory that uses air-cooled, direct expansion cooling. In coastal climates (i.e. climate zone 1, 3 & 5) cooling requirements will generally be less than the inland zones (i.e. climate zone 2, 4, 11, 12 & 13).

***Terms and Conditions***

Customer must have electricity or gas distributed by PG&E to the installation address. The customer must meet all terms and conditions as described on the program specifications.

***Market Applicability***

This measure is applicable to duct testing and sealing in residential mobile homes, single family, and multifamily properties containing two or more units.

## 1.2 Product Technical Description

This work paper covers energy savings for the duct seal measure.

The duct seal measure involves duct tightness testing and sealing of central forced air residential, direct expansion (DX) HVAC systems. When an HVAC system’s duct system is leaky on the supply side it will fail to deliver conditioned air to the appropriate spaces, with much of that leakage going directly to the outdoors, thus wasting energy. Return air leakage brings in hot outdoor and attic air which reduces the cooling capacity of the system.

## 1.3 Measure Application Type

The Delivery Mechanism of these measures is the Direct Install (Midstream) Program – midstream incentive. The incentives are provided to the third party implementer and HVAC contractors.

The Program Type/Application Type of these measures is Retro-Commissioning (RC). RC uses the effective useful life (EUL) for the measure life basis.

Table 3: Measure Application Type

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| RC | Retro-Commissioning | Measure applied as part of retro-commissioning; Above Pre-Existing energy impacts are applied for the associated EUL period, Full Cost of measure technology used. |

Note: See Appendix A for a comparison of the application types used by and incorporated into SCE systems versus the application types available in the newest revision of DEER 2015. Appendix A will serve as a translation between the outputs of this workpaper and application types used by READi.

## 1.4 Product Base Case and Measure Case Data

### 1.4.1 DEER Base Case and Measure Case Information

## The DEER2015[[1]](#endnote-1) data cited in this work paper include: peak demand reduction, electric savings, interactive gas savings, equipment useful life, net-to-gross and measure load shapes.

Table 4: DEER Difference Summary

|  |  |
| --- | --- |
| DEER Difference Summary Table | |
| Modified DEER Methodology | No |
| Scaled DEER Measure | No |
| DEER Building Prototypes Used | Yes |
| Deviation from DEER | None |
| DEER Version | DEER2015 READi v.2.1.0 |
| DEER Run ID and Measure Name (Sample) | Res-DuctSeal-HighToLow-wtd; Res-DuctSeal-MedToLow-wtd |

**Net to Gross**

The NTG ratio was obtained from the “DEER2011\_NTGR\_2012-05-16.xls” spreadsheet under the “DEER2011 NTGr Values” tab on the [www.deeresources.com](http://www.deeresources.com) website. Table 6 below summarizes all applicable DEER based Net-to-Gross ratios for programs that may be used by this measure.

See Section 1.1 Terms and Conditions and Market Applicability to reference the type of program delivery mechanism and customer status used to determine this entry.

Table 5: Net-to-Gross Ratio

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| NTGR\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID\* | NTG\* |
| Res-sAll-mDuctSeal | Duct Sealing | Res | Any | PreReb | 0.78 |

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

**Installation Rate (GSIA)**

The installation rate (IR) is identified in the calculation attachment. This value is obtained from the support table available in READi. Currently there is no versioning on the installation rate table. To address appropriate selection of the installation rate the date of the workpaper will serve as the last date checked for updated IR values. The installation rate varies by end use, sector, technology, application, and delivery method. The relevant IR values for this measure are shown in Table 6 below.

Table 6: Installation Rate

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| GSIA\_ID\* | Description\* | Sector\* | BldgType\* | ProgDelivID\* | GSIAValue\* |
| Res-DuctSeal-PGE | Residential Duct Sealing; Annual Installation Rate | Res | Any | Any | 0.584 |

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

**Spillage Rate**

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.

**READi Technology Fields**

To support the development of the ED ex ante tables, select fields from the ex-ante database will be identified in the workpaper. For a full set of values associated with the measures in the workpaper refer the Excel calculation template. (In the event that the READi IDs do not support the technology in this workpaper simply indicate “Non-DEER”.)

Table 7: READi Tech IDs

|  |  |
| --- | --- |
| READi Field Name | Air Conditioner |
| Measure Case UseCategory | HVAC |
| Measure Case UseSubCats | VentAirDist |
| Measure Case TechGroups | HV\_AirDist |
| Measure Case TechTypes | DuctLeak |
| Base Case TechGroups | HV\_AirDist |
| Base Case TechTypes | DuctLeak |

**Effective Useful Life / Remaining Useful Life:**

DEER14 update documentation provides EUL and RUL information to be used for the 2015 program year on [www.deeresources.com](http://www.deeresources.com). The DEER documentation “DEER2014-EUL-table-update\_2014-02-05.xlsx” 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 DEER14 update documentation, “DEER2014-EUL-table-update\_2014-02-05.xlsx” [436], was used. Table 8 below identifies the value/methodology used for the measures in this work paper.

Table 8: EUL/RUL Value/Methodology

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **READi EUL ID** | **Description** | **Sector** | **Enduse** | **EUL (Years)** | **RUL (Years)** |
| HV-DuctSeal | Duct Sealing | Res | HVAC | 18 | 6 |

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

Table 9: Code Summary

|  |  |  |
| --- | --- | --- |
| Code | Applicable Code Reference | Effective Dates |
| Title 24 (2013) | Title 24, 2013 (Residential Compliance Manual-Building HVAC Requirements) Section 120.4, 140.4(1), Table 150.0, and RA3.1. | January 1, 2015 |
| Title 20 (2014) | Does not fall under Title 20 |  |
| Federal Codes (DOE / EPA) | Does not fall under Federal DOE or EPA Energy Regulations |  |

***Title 20:*** This measure does not fall under Title 20 of the California Energy Regulations.

***Title 24:*** This measures do fall under Title 24 2013 of the California Energy Regulations. Under this

regulation, the following is required for any new installation of air-cooled air conditioners and air-source heat pumps:

Duct systems must be sealed and verified if >40 feet of ducts in unconditioned space. Duct system leakage must be ≤15% in total, or ≤10% to the outside. Or, if unable to meet the sealing requirements, all accessible leaks must be sealed and verified by a HERS rater

Mandatory duct insulation requirements (R-6) apply to all new or replacement ducts (not existing or unaltered ducts). When replacing >40 feet of ducts in unconditioned space: CZ1-10 and 12-13: R-6 CZ11 and 14-16; R-8. HERS verification is required for insulated ducts n conditioned space.

In all climate zones, when new duct systems are installed in unconditioned space, leakage must be ≤6% of the air handler airflow.

***Federal Standards:*** This measure does not fall under Federal DOE or EPA Energy Regulations.

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

Several studies have been performed concerning the energy savings potential through DTS. The key reports are summarized in this section.

**LBNL April 2002 Study2**

“Comparison between Predicted Duct Effectiveness from Proposed ASHRAE Standard 152 and Measured Field Data for Residential Forced Air Cooling Systems”; LBNL-50008; Siegel, McWilliams, Walker; April 2008.[[2]](#endnote-2)

The study focused on comparing calculated results from the 2002 version of ASHRAE Standard 152P, “Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems”, with field test data. Field tests were performed on cooling systems in 11 homes in California, Nevada and Texas. Some homes had vented attics with ceiling insulation and some had non-vented attics with roof insulation. The systems were tested under various summer conditions and with various amounts of duct leakage. In some cases holes were cut in the duct work to simulate higher leakage rates.

ASHRAE Standard 152[[3]](#endnote-3) gives a method for calculating overall duct distribution system efficiency for HVAC systems. The results of the LBNL study showed that the difference between measured duct system delivery effectiveness and that calculated per ASHRAE Standard 152 is approximately 5% if weather data, duct leakage and air handler flow are well known.

**ACEEE Summer 1999 Study4**

“National Energy Savings Potential from Addressing Residential HVAC Installation”; 1999 ACEEE Summer Study Proceedings; Neme, Proctor, Nadel; February 1999.[[4]](#endnote-4)

This paper summarizes several studies on various HVAC unit installation problems. For duct sealing, 19 separate studies are cited. Sample sizes vary from three to over 10,000 units. The methods of calculating savings and the sealed tightness of the duct systems vary between the studies. Average duct leakage to outdoors is 270 cfm and energy savings potential is 17%.

**LBNL December 1997 Study5**

“Field Investigation of Duct System Performance in California Light Commercial Buildings;” LBNL-40102; Delp, Matson, Tschudi, Modera, Diamond; December 1997.[[5]](#endnote-5)

Duct system performance in fifteen HVAC systems in eight Northern California buildings was evaluated. All of the buildings had ducts located in the cavity between the dropped ceiling and the roof deck. In 50% of the buildings, the cavity was functionally outside the building’s air and thermal barrier. The average leakage rate was determined to be 90 cfm/ton or 259 cfm/sq ft of conditioned area.

**SCE Light Commercial DTS and RCA Study6**

“A Campaign to Reduce Light Commercial Peak Load in the Southern California Edison Service Territory through Duct Sealing and A/C Tune-Ups”; Modera, Proctor; October 2002.[[6]](#endnote-6)

Light commercial duct systems were tested and sealed in SCE territory. The study includes 447 units tested with 367 sealed. Tests show an average initial leakage rate of 36% with an average post retrofit leakage rate of 6%. Calculated savings per the ASHRAE Standard 152 method are 25% for cooling and 15% for heating.

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

There are no further data or calculations provided for the support of the measures in this work paper. The savings were downloaded from DEER2015 directly.

# Section 2. Calculation Methods

Table 10 contains the data files for measures that are taken directly from the DEER 2015 READi Tool. These results for the air conditioners and heat pumps measures have not been modified, only the furnaces were modified to reflect the units of “per household”.

Table 10 READi Tool Outputs

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **PG&E Measure Code** | **SCG and SDG&E Solution Code** | **SCE Solution Code** | **Measure Name** | **READi Results** |
| HV286 |  |  | Residential: Duct Sealing (Total Leakage Reduced from (35/40%) to (15/12%)) | accompanying calculation spreadsheet |
| H768 |  |  | Residential: Duct Sealing (Total Leakage Reduced from (25/24%) to (15/12%)) | accompanying calculation spreadsheet |

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***RC*** | EUL | Calculated as Full Measure Cost | N/A |

Note: For RC measure, First Baseline is the baseline for the full EUL. There is no second baseline.

## 2.1 Electric Energy Savings Estimation Methodologies

Energy savings for the duct leakage reduction (Impact ID: Res-DuctSeal-MedToLow-wtd and Res-DuctSeal-HighToLow-wtd) measure were downloaded from the DEER2015 READI tool (v2.1.0). This measure includes HVAC interactive effects savings.

Specified values vary by building types and climate zones. For this work paper, a building type of residential single family, multifamily, and mobile homes was chosen, along with using “existing (weighted DEER vintages)” building vintage and all PG&E nine (9) California Climate Zones.

See accompanying calculation spreadsheet for complete list of measure case savings.

## 2.2. Demand Reduction Estimation Methodologies

Demand savings for the duct leakage reduction (Impact ID: Res-DuctSeal-MedToLow-wtd and Res-DuctSeal-HighToLow-wtd) measure were downloaded from the DEER2015 READI tool (v2.1.0). This measure includes HVAC interactive effects savings.

Specified values vary by building types and climate zones. For this work paper, a building type of residential single family, multifamily, and mobile homes was chosen, along with using “existing (weighted DEER vintages)” building vintage and all PG&E nine (9) California Climate Zones.

See accompanying calculation spreadsheet for complete list of measure case savings.

## 2.3. Gas Energy Savings Estimation Methodologies

Gas savings for the duct leakage reduction (Impact ID: Res-DuctSeal-MedToLow-wtd and Res-DuctSeal-HighToLow-wtd) measure were downloaded from the DEER2015 READI tool (v2.1.0). This measure includes HVAC interactive effects savings.

Specified values vary by building types and climate zones. For this work paper, a building type of residential single family, multifamily, and mobile homes was chosen, along with using “existing (weighted DEER vintages)” building vintage and all PG&E nine (9) California Climate Zones.

See accompanying calculation spreadsheet for complete list of measure case savings.

# *Section 3. Load Shapes*

## 3.1 Base Case 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:HVAC\_Eff\_AC load shape. See the KEMA report[[7]](#endnote-7) for a more thorough discussion regarding the load shapes for this measure.

Building Types and Load Shapes

|  |  |  |
| --- | --- | --- |
| **Building Type** | **E3 Alt. Building Type** | **Load Shape** |
| Residential | RES | 26 = Res. Central Air Conditioning |

## 3.2 Measure Load Shapes

The measure load shape is the same as the base case load shape, 26 = Res. Central Air Conditioning

# Section 4. Base Case & Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Measure Life Basis** | **First Baseline Period Gross Measure Cost (RUL)** | **Second Baseline Period Gross Measure Cost (EUL – RUL)** |
| ***RC*** | EUL | Calculated as Full Measure Cost | N/A |

Note: For RC measure, First Baseline is the baseline for the full EUL. There is no second baseline.

## 4.1 Base Case(s) Costs

This is a service measure. There are no base case costs.

## 4.2 Measure Case Costs

The 2010-2012 WO017 Ex-Ante Measure Cost Study[[8]](#endnote-8) was used in determining the costs of these measures. The following Transaction types are appropriate to these measures. The Base Case Costs are:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building Type** | **Transaction** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| H768, HV286 | SFM, MFM | RC | Ex | $71.45 | $181.24 | $0.00 | $252.69 |
| H768,  HV286 | DMO | RC | Ex | $30.62 | $78.54 | $0.00 | $109.16 |

*All costs are noted as $ per household.*

## 4.3 Incremental & Full Measure Costs

|  |  |  |  |
| --- | --- | --- | --- |
| **Install/Program Type** | **Gross Measure Cost**  **(RUL Period/First Baseline)** | **Gross Measure Cost**  **(EUL-RUL Period/ Second Baseline)** | **Incremental Measure Cost** |
| ***RC*** | EUL | Calculated as Full Measure Cost | N/A |

Note: For RC measure, First Baseline is the baseline for the full EUL. There is no second baseline.

### 4.3.1 *Full Measure Cost*

Full Measure Cost is the cost to install an energy efficient measure per the CPUC calculators. This definition implies a different meaning depending on the Measure Application type.

This measure transaction type is: RC, so the Full Measure Cost (FMC) is represented by the equation below:

FMC = Measure Equipment Cost + Measure Labor Cost

\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.

### 4.3.2 Incremental Measure Costs

Incremental Measure Cost is the premium cost to install an energy efficient measure over a standard efficiency measure or code baseline measure. While IMC has a straight forward definition depending on the install type, the equation does vary.

This measure transaction type is: RCso the Incremental Measure Cost (IMC) is represented by the equation below:

IMC = Measure Equipment Cost + Measure Labor Cost

\*Note: Various complicated price fluctuations are not addressed in these equations, such as future costs due to inflation in labor, future costs due to deflation in material cost, and other variables that cannot be accurately described at this time.

**Summary Table for Section 4**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building Type** | **Transaction** | **Baseline** | **Equipment Cost** | **Labor / Installation Cost** | **Maintenance / Other Cost** | **Total Measure Case Cost** |
| H768, HV286 | SFM, MFM | RC | Ex | $71.45 | $181.24 | $0.00 | $252.69 |
| H768,  HV286 | DMO | RC | Ex | $30.62 | $78.54 | $0.00 | $109.16 |

*All costs are noted as $ per household.*

# Input Appendices

|  |  |  |
| --- | --- | --- |
| **Code** | **Description** | **Comment** |
| RC | Retro-commissioning | Single baseline (above code), full costs |

Notes: For RC measure, First Baseline is the baseline for the full EUL. There is no second baseline.

## A. (1.4.1) DEER Base Case and Measure Case Information

Electric Savings **(ΔW):**

The following table shows impact savings for mobile homes in climate zone 11 for the measures listed in this program and work paper.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure ID** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Electric Savings Watts (kW)** | **Deer units** | **DEER Version** | **Impact IDs** |
| H768 | DMO | Ex | Z11 | 0.1710 | Household | DEER2015 | Res-DuctSeal-MedToLow-wtd |
| HV286 | DMO | Ex | Z11 | 0.7220 | Household | DEER2015 | Res-DuctSeal-HighToLow-wtd |

See accompanying calculation spreadsheet for complete list of measure case savings.

**Annual Electric Savings** **(ΔkWh):**

The following table shows impact savings for mobile homes in climate zone 11 for the measures listed in this program and work paper.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Electric Savings kWh** | **DEER units** | **DEER Version** | **Impact IDs** |
| H768 | DMO | EX | Z11 | 292.00 | Household | DEER2015 | Res-DuctSeal-MedToLow-wtd |
| HV286 | DMO | EX | Z11 | 598.00 | Household | DEER2015 | Res-DuctSeal-HighToLow-wtd |

See accompanying calculation spreadsheet for complete list of measure case savings.

Gas Savings **(ΔTh):**

The following table shows impact savings for mobile homes in climate zone 11 for the measures listed in this program and work paper.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Measure Code** | **Building type** | **Bldg Vintage** | **Climate Zone** | **Interactive Only?**  **Yes / No** | **Gas Savings Therms** | **DEER units** | **DEER Version** | **Impact IDs** |
| H768 | DMO | EX | Z11 | Yes | 25.80 | Household | DEER2015 | Res-DuctSeal-MedToLow-wtd |
| HV286 | DMO | EX | Z11 | Yes | 66.20 | Household | DEER2015 | Res-DuctSeal-HighToLow-wtd |

See accompanying calculation spreadsheet for complete list of measure case savings.

**Hours of Operation**:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Hours of Operation hrs/yr** | **DEER Version** | **Impact IDs** |
| SFM, MFM, DMO | Ex | PGE | DEER hours (EFLH) | DEER2015 | Res-DuctSeal-MedToLow-wtd |
| SFM, MFM, DMO | Ex | PGE | DEER hours (EFLH) | DEER2015 | Res-DuctSeal-HighToLow-wtd |

**Base Case Costs and Measure Case Costs**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | | | **Costs ($)** | | |  | |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **Base Case** | **Measure Case** | **IMC** | **DEER Version** | **Impact IDs** |
| SFM, MFM | Ex | PGE | $0 | $71.45 | $181.24 | WO017 report | Res-DuctSeal-MedToLow-wtd |
| DMO | Ex | PGE | $0 | $30.62 | $78.54 | WO017 report | Res-DuctSeal-HighToLow-wtd |

*All costs are noted as $ per household.*

**Effective Useful Life/ Remaining Useful Life:**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **EUL (yrs)** | **RUL (yrs)** | **DEER Version** | **Impact IDs** |
| SFM, MFM, DMO | Ex | PGE | 18 | 6 | DEER2015 | Res-DuctSeal-MedToLow-wtd; Res-DuctSeal-HighToLow-wtd |

**In service rate:**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Building type** | **Bldg Vintage** | **Climate Zone** | **In service rate** | **DEER Version** | **Impact IDs** |
| SFM, MFM, DMO | Ex | PGE | 0.584 | DEER2015 | Res-DuctSeal-MedToLow-wtd;  Res-DuctSeal-HighToLow-wtd |

# References

1. JJHirsch & Associates, “2015 Database for Energy Efficiency Resources”, Version 2.1.0, October 2014.

   [www.deeresources.com](http://www.deeresources.com) [↑](#endnote-ref-1)
2. Siegel, McWilliams, Walker, “Comparison Between Predicted Duct Effectiveness from Proposed ASHRAE Standard 152 and Measured Field Data for Residential Forced Air Cooling Systems.” LBNL-50008; April 2008. [↑](#endnote-ref-2)
3. American Society of Heating, Refrigerating, and Air-Conditioning Engineers, “Method of Test for Determining the Design and Seasonal Efficiencies of Residential Thermal Distribution Systems.” ISSN 1041-2336, ANSI/ASHRAE Standard 152-2004. [↑](#endnote-ref-3)
4. Neme, Proctor, Nadel, “National Energy Savings Potential From Addressing Residential HVAC Installation.” ACEEE Summer Study Proceedings; February 1999. [↑](#endnote-ref-4)
5. Delp, Matson, Tschudy, Modera, Diamond, “Field Investigation of Duct System Performance in California Light Commercial Buildings.” LBNL-40102, December 1997. [↑](#endnote-ref-5)
6. Modera, Proctor, “A Campaign to Reduce Light Commercial Peak Load in the Southern California Edison Service Territory Through Duct Sealing and A/C Tune-Ups,” October 2002. [↑](#endnote-ref-6)
7. KEMA Inc., JJ Hirsch and Assoc., Itron Inc, Final Report - Load Shape Update Initiative, Prepared for the California Public Utility Commission Under contract to Pacific Gas and Electric Company, revised 11/17/2006 [↑](#endnote-ref-7)
8. Iron, Inc. “2010-2012 WO017 Ex Ante Measure Cost Study- Draft Report”, February 28, 2014.

   <https://www.pge.com/regulation/EnergyEfficiency2015-BeyondRollingPortfolios/Reports/ED/2014/EnergyEfficiency2015-BeyondRollingPortfolios_Report_ED_20140311_298640Atch01_298641.pdf> [↑](#endnote-ref-8)