|  |
| --- |
| HVAC  Duct Seal, Residential  SWSV001-03 |

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Measure Name

Duct Seal, Residential

Statewide Measure ID

SWSV001-03

Technology Summary

The duct sealing measure involves duct tightness testing and sealing of central forced air residential, direct expansion (DX) Heating, Ventilation, and Air Conditioning (HVAC) systems. When a HVAC 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.

Several studies have examined energy savings potential through duct testing and sealing:

***Comparison between Predicted Duct Effectiveness from Proposed ASHRAE Standard 152 and Measured Field Data for Residential Forced Air Cooling Systems (Siegel, McWilliams, and Walker; 2008).***[[1]](#footnote-2) This study, conducted by Lawrence Berkeley National Lab (LBNL), 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[[2]](#footnote-3) gives a method for calculating overall duct distribution system efficiency for HVAC systems. The results of the 2008 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.

***National Energy Savings Potential from Addressing Residential HVAC Installation (Neme, Proctor, and Nadel; 1999).***[[3]](#footnote-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%.

***Field Investigation of Duct System Performance in California Light Commercial Buildings (Delp, Matson, Tschudi, Modera, and Diamond;1997).***[[4]](#footnote-5) Duct system performance in 15 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/ft2 of conditioned area.

***A Campaign to Reduce Light Commercial Peak Load in the Southern California Edison Service Territory through Duct Sealing and A/C Tune-Ups (Modera and Proctor; 2002).***[[5]](#footnote-6) Light commercial duct systems of buildings in the Southern California Edison (SCE) service area were tested and sealed. The study includes 447 units tested with 367 sealed. Tests showed an average initial leakage rate of 36% with an average post-retrofit leakage rate of 6%. Calculated savings per the ASHRAE Standard 152 method were 25% for cooling and 15% for heating.

Measure Case Description

This measure is defined as duct sealing to reduce total leakage from “high” or “medium” leakage rate to a “low” leakage rate, as specified by residence type (single family, multifamily, and double-wide mobile home). Both measure cases are to go to a “low” leakage rate after the duct is sealed. The “low” leakage rate is defined as a 12% leakage rate for single family (SFm) and multifamily (MFm), and a 15% leakage rate for double-wide mobile home (DMo). The energy and demand impacts of this measure also vary by climate zone.

Measure Case Specification

|  |  |  |  |
| --- | --- | --- | --- |
| **Statewide Measure Offering ID** | **Base Case Leakage Rate Tier** | **Residence Type** | **“Low” Measure Case  Leakage Rate** |
| SWSV001F  SWSV001H | High to Low | Single family  Multifamily | 12% |
| SWSV001D | Double-wide mobile home | 15% |
| SWSV001E  SWSV001G | Medium to Low | Single family  Multifamily | 12% |
| SWSV001C | Double-wide mobile home | 15% |
| SWSV001L  SWSV001N | High to Low | Single family rNCGF System Only  Multifamily rNCGF System Only | 12% |
| SWSV001J | Double-wide mobile home rNCGF System Only | 15% |
| SWSV001K  SWSV001M | Medium to Low | Single family rNCGF System Only  Multifamily rNCGF System Only | 12% |
| SWSV001I | Double-wide mobile home rNCGF System Only | 15% |

Base Case Description

The base case is defined as a single family, multifamily, or double-wide mobile home with high or medium duct leakage rate as specified by residence type (single family, multifamily, and double-wide mobile home). The baseline for the “high” leakage rate of the existing duct is a 40% leakage rate for SFm/MFm, and a 35% leakage rate for DMo. The “medium” leakage rate of the existing duct is a 24% leakage rate for SFm/MFm and a 25% leakage for DMo.

Base Case Specification

|  |  |  |  |
| --- | --- | --- | --- |
| **Statewide Measure Offering ID** | **Base Case Leakage Rate Tier** | **Residence Type** | **Base Case Leakage Rate** |
| SWSV001F  SWSV001H | High | Single family  Multifamily | 40%  (20% supply/20% return) |
| SWSV001D | Double-wide mobile home | 35% (supply) |
| SWSV001E  SWSV001G | Medium | Single family  Multifamily | 24% |
| SWSV001C | Double-wide mobile home | 25% |
| SWSV001L  SWSV001N | High | Single family rNCGF System Only  Multifamily rNCGF System Only | 40%  (20% supply/20% return) |
| SWSV001J | Double-wide mobile home rNCGF System Only | 35% (supply) |
| SWSV001K  SWSV001M | Medium | Single family rNCGF System Only  Multifamily rNCGF System Only | 24% |
| SWSV001I | Double-wide mobile home rNCGF System Only | 25% |

Code Requirements

This measure is subject to the California Building Energy Efficiency Standards (Title 24) [[6]](#footnote-7) which stipulates the following duct system requirements for any *new* installation of air-cooled air conditioners and air-source heat pumps:

* For alterations and extensions of existing duct work 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 Home Energy Rating System (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 in climate zones 1 through10 and in climate zones 12 and 13, R-6 is required.
  + When replacing > 40 feet of ducts in unconditioned space in climate zones in climate zones 11 and 14-16, R-8 is required.
* HERS verification is required for insulated ducts in conditioned space.
* In all climate zones, where new duct systems are installed in unconditioned space, leakage must be ≤ 5% of the air handler air flow.

This measure does not fall under federal regulations.

Applicable State and Federal Codes and Standards

| **Code** | **Applicable Code Reference** | **Effective Date** |
| --- | --- | --- |
| CA Appliance Efficiency Regulations – Title 20 | None. | n/a |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 120.4, 140.4(1), and RA3.1. | January 1, 2020 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 150.2(b) 1D Altered Duct Systems – Duct Sealing | January 1, 2020 |
| CA Building Energy Efficiency Standards – Title 24 (2019) | Section 10.103 Permits, Fees, Applications, and Inspections | January 1, 2020 |
| Federal Standards | None. | n/a |

Normalizing Unit

Tons of cooling capacity (Cap-Tons)

No Cooling Gas Furnace (rNCGF) (Cap-kBTUh)

Program Requirements

Measure Implementation Eligibility

All combinations of measure application type, delivery type, and sector that are established for this measure are specified below. Measure application type is a categorization based on the circumstances and timing of the measure installation; each measure application type is distinguished by its baseline determination, cost basis, eligibility, and documentation requirements.  Delivery type is the broad categorization of the delivery channel through which the market intervention strategy (financial incentives or other services) is targeted. This table also designates the broad market sector(s) that are applicable for this measure.

*Note that some of the implementation combinations below may not be allowed for some measure offerings by all program administrators.*

Implementation Eligibility

|  |  |  |
| --- | --- | --- |
| **Measure Application Type** | **Delivery Type** | **Sector** |
| BRO-RCx | DnDeemDI | Res (SFm & MFm 2006 & post) |
| BW | DnDeemDI | Res (DMo) |
| BW | DnDeemDI | Res (SFm & MFm pre-2006) |

Eligible Products

The duct test and seal programs for residential mobile homes, multifamily homes, and single-family homes eligible for a direct-install delivery approach. Up to two duct tests must be conducted: the first or “test-in” is a system check to determine whether the duct system tightness meets the California Title 24 specifications. If the Test-in shows that duct leakage exceeds minimum tightness specifications, and the technicians correct the situation, then a second test or “test-out” must be conducted to verify proper duct tightness was achieved. Energy savings are associated with the test-out procedure; energy savings are not assigned to the “test-in” procedure.

To identify these measures as part of an existing HVAC system, the program implementer must record existing duct leakage through comprehensive field testing. The testing can be performed while the system is pressurized using a duct blower fan to ensure the target leakage thresholds are achieved. Duct sealing shall be performed on the unpressurized system. After installation, testing shall be performed to ensure the target leakage thresholds are achieved. Any test compliant with the Title 24 2019 Residential Compliance Manual[[7]](#footnote-8) can be used to justify duct leakage for this measure, such as the total leakage or the leakage to outside tests. Photos and test results can serve as documentation that the work was performed on an existing HVAC system.

Per Resolution E-5082 “duct connections must not be sealed with duct tape (cloth-backed rubber adhesive tapes). Mastic or aerosol sealant materials are preferred, and butyl tape can be used where mastic or aerosol are impractical.”[[8]](#footnote-9)

Programs often bundle Quality Maintenance (QM) measures. The following prerequisites must be met before the QM treatments, such as airflow adjustments, can be implemented to ensure an HVAC system is running optimally.

* The unit and system must be capable of delivering a supply air flow rate of at least 350 cfm/ton after treatments related to air flow are completed and before refrigerant charge is tested and/or adjusted.
* The unit must be drawing power.
* The unit must have a condenser over ambient temperature (COAT) of at least 3 degrees.
* An assessment and report are required in accordance with Air Conditioning Contractors of America (ACCA) Standard 4[[9]](#footnote-10) prior to any treatments being applied to determine the baseline conditions and to develop QM treatment recommendations.

The 350 cfm/ton air flow requirement ensures that the refrigerant system can be properly diagnosed and charged. If the system is not delivering 350 cfm/ton upon initial inspection, an assessment should be made to determine if the system will be able to deliver 350 cfm/ton by implementing some or all of the QM treatments related to air flow. If it is determined that the supply fan and duct system in place do not have the capability to deliver 350 cfm/ton after the air flow treatments have been performed, refrigerant charge cannot be properly diagnosed, rendering the QM process incomplete and the savings in this work paper invalid.

If some or all of the existing ductwork is beyond repair and sections must be replaced, the sections that must be replaced must be less than 40 linear feet in total per Section 150.2(b) of the 2019 California Building Energy Efficiency Standards (Title 24),[[10]](#footnote-11) or the replaced ductwork must be installed and tested in accordance with the applicable requirements in 2019 Title 24 Section 150.2(b)1D.

Eligible Building Types and Vintages

This measure is applicable for any existing single family, multifamily with two or more units, or mobile home that uses air-cooled, direct expansion (DX) cooling and gas heating, heat pump, or gas heating with no cooling. To confirm that the correct vintage savings are being used, the building age should be verified. See below for details on DEER 2020 vintage years for Old and Median (Existing) vintage buildings[[11]](#footnote-12):

* Old: Before 2002 for non-mobile homes, before 1995 for mobile homes
* Median (Existing): 2002 to 2016 for non-mobile homes, 1995 to 2005 for mobile homes

Eligible Climate Zones

This measure is applicable in all California climate zones. 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).

Program Exclusions

None.

Data Collection Requirements

In order to verify compliance with measure requirements and the correct measure selection, the following information must be collected for each installation:

* Building information such as: building type, vintage (year), and climate zone
* HVAC System type, capacity in tons (for systems with cooling) or kBTUh (for sytems with no heating), make and model number
* Duct testing information include:
  + Type of duct test conducted
  + Pre and post install duct leakage rate percentages
  + Duct sealing material used

Use Category

Service

Electric Savings (kWh)

The electric energy savings from the residential duct testing and sealing measure were drawn directly from the 2021 DEER energy impact data released on 11/19/2020, version DEER 2021 (D20v0 & D20v1). Created DEER2021 EnergyImpact records for two residential duct sealing measures so that BldgHVAC=rNCGF uses NormUnit=kBTUh (corrected from NormUnit=Tons). See [*Res\_Duct-Sealing\_NormUnit=kBtuh\_rNCGF\_2020-11-19.xlsx*](https://nam01.safelinks.protection.outlook.com/?url=http%3A%2F%2Fdeeresources.com%2Ffiles%2Fdeerchangelog%2FRes_Duct-Sealing_NormUnit%3DkBtuh_rNCGF_2020-11-19.xlsx&data=04%7C01%7Ctxv0%40pge.com%7C37122a7de7ab4e6ad3ec08d88d97487a%7C44ae661aece641aabc967c2c85a08941%7C0%7C1%7C637415028272823145%7CUnknown%7CTWFpbGZsb3d8eyJWIjoiMC4wLjAwMDAiLCJQIjoiV2luMzIiLCJBTiI6Ik1haWwiLCJXVCI6Mn0%3D%7C1000&sdata=qg6ZnbONb4V7UsyrjXNhaW5DLH8M1gAdIxiDFUaPh40%3D&reserved=0) for conversion factors used. The savings of this measure includes HVAC interactive effects savings. The results were reported for the following DEER Impact IDs:

| **Statewide Measure Offering ID** | **Energy Impact ID** | **Measure Description** | **MAT** | **Vintage(s)** | **HVAC Type(s)** |
| --- | --- | --- | --- | --- | --- |
| SWSV001C | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (25% to 15%) for DMo | BW | Ex, Old | rDXGF, rDXHP, rWtd |
| SWSV001D | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (35% to 15%) for DMo | BW | Ex, Old | rDXGF, rDXHP, rWtd |
| SWSV001E | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (24% to 12%) for SFm MFm Pre 2006 | BW | Ex, Old | rDXGF, rDXHP, rWtd |
| SWSV001F | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (40% to 12%) for SFm MFm Pre 2006 | BW | Ex, Old | rDXGF, rDXHP, rWtd |
| SWSV001G | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (24% to 12%) for SFm MFm 2006 and post 2006 | BRO-RCx | Ex | rDXGF, rDXHP, rWtd |
| SWSV001H | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (40% to 12%) for SFm MFm 2006 and post 2006 | BRO-RCx | Ex | rDXGF, rDXHP, rWtd |
| SWSV001I | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (25% to 15%) for Dmo with rNCGF System Only | BW | Ex, Old | rNCGF |
| SWSV001J | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (35% to 15%) for Dmo with rNCGF System Only | BW | Ex, Old | rNCGF |
| SWSV001K | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (24% to 12%) for SFm MFm Pre 2006 with rNCGF System Only | BW | Ex, Old | rNCGF |
| SWSV001L | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (40% to 12%) for SFm MFm Pre 2006 with rNCGF System Only | BW | Ex, Old | rNCGF |
| SWSV001M | RB-HV-DuctSeal-MedToLow | Duct Seal and Test, Residential, Medium (24% to 12%) for SFm MFm 2006 and post 2006 with rNCGF System Only | BRO-RCx | Ex | rNCGF |
| SWSV001N | RB-HV-DuctSeal-HighToLow | Duct Seal and Test, Residential, High (40% to 12%) for SFm MFm 2006 and post 2006 with rNCGF System Only | BRO-RCx | Ex | rNCGF |

Note that the measure impacts are based on recent DEER2021 updates that affect “APreWBkWh” for energy, “APreWBkW” for peak demand and “APreWBtherm”. Savings values were reported by building type (residential single family, multifamily, and mobile home), climate zone, and HVAC system type. Both Old and Existing vintage impacts are available for all mobile home measures. Single family and multifamily buildings must select the correct measure for Old or Existing vintages due to the impacts of code on the approved measure application type (MAT) for those building types.

Peak Electric Demand Reduction (kW)

The peak demand reduction for the residential duct testing and sealing measure were drawn directly from the 2021 DEER energy impact data released on 11/19/2020, version DEER 2021 (D20v0 & D20v1). The impacts of this measure account for HVAC interactive effects savings. The results were reported for the following DEER Impact IDs:

Res-DuctSeal-MedToLow

Res-DuctSeal-HighToLow

Peak demand reduction was reported by building type (residential single family, multifamily, and mobile home), climate zone, and HVAC system type. Both Old and Existing vintage impacts are available for all mobile home measures. Single family and multifamily buildings must select the correct measure for Old or Existing vintages due to the impacts of code on the approved measure application type (MAT) for those building types.

Gas Savings (Therms)

The gas energy savings for the residential duct testing and sealing measure were drawn directly from the 2021 DEER energy impact data released on 11/19/2020, version DEER 2021 (D20v0 & D20v1). The results were reported for the following DEER Impact IDs:

Res-DuctSeal-MedToLow

Res-DuctSeal-HighToLow

Savings values were reported by building type (residential single family, multifamily, and mobile home), climate zone, and HVAC system type. Both Old and Existing vintage impacts are available for all mobile home measures. Single family and multifamily buildings must select the correct measure for Old or Existing vintages due to the impacts of code on the approved measure application type (MAT) for those building types.

Life Cycle

Effective useful life (EUL) is an estimate of the median number of years that a measure installed through a program is still in place and operable. Remaining useful life (RUL) is an estimate of the median number of years that a technology or piece of equipment replaced or altered by an energy efficiency program would have remained in service and operational had the program intervention not caused the replacement or alteration.

The EUL and RUL specified for duct testing and sealing are presented below. The EUL value for the BRO-RCx MAT was stipulated in Resolution E-4952,[[12]](#footnote-13) which updated the Database for Energy Efficient Resources (DEER) for 2019 and 2020. The EUL updates in Resolution E-4952 complies with Decision 16-08-019[[13]](#footnote-14) issued by the California Public Utilities Commission in 2016, which created the Behavioral, Operational, and Retrocommissioning (BRO) measure classification and the associated EUL values of one to three years; this Decision assigned an EUL of three years for BRO retrocommissioning measures (BRO-RCx).

The EUL value for the building weatherization (BW) measure application type (MAT) was stipulated in Resolution E-5082, which reclassified duct sealing for pre-2006 buildings. Per Resolution E-5082, the BW MAT shall only be eligible for measures installed in buildings constructed pre-2006.[[14]](#footnote-15) For buildings constructed after January 1, 2006, the BRO EUL of three years per Resolution E-4952 will remain in effect. Furthermore, Resolution E-5082 stipulates that duct sealing in all mobile homes shall be classified as BW types, since mobile homes do not have a requirement for duct sealing under the U.S. Department of Housing and Urban Development code.

The RUL for this measure conforms with Version 5 of the Energy Efficiency Policy Manual, which recommends “one-third of the effective useful life in DEER as the remaining useful life until further study results are available to establish more accurate values.”[[15]](#footnote-16) This approach provides a reasonable RUL estimate without the requiring any a priori knowledge about the age of the equipment being replaced.[[16]](#footnote-17) Further, as per Resolution E-4807, the California Public Utilities Commission (CPUC) revised retrofit add-on (REA) measures so that the EUL of the measure is equal to the lower of the RUL of the modified system or equipment or the EUL of the add-on component.”[[17]](#footnote-18)

Prior to issuance of Resolution E-4952, the EUL of residential duct sealing was based upon several retention studies documented for the DEER 2014 update.[[18]](#footnote-19)

Effective Useful Life and Remaining Useful Life

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter** | **MAT** | **Value** | **Source** |
| EUL (yrs) | BRO-RCx | 3.0 | California Public Utilities Commission (CPUC). 2018. Resolution E-4952. October 11. Page A-36, A-37. |
| RUL (yrs) | BRO-RCx | 1.0 |
| EUL (yrs) | BW | 18.0 | California Public Utilities Commission (CPUC). 2020. *Resolution E-5082*. August 27. Page 13. |
| RUL (yrs) | BW | 6.0 |

Base Case Material Cost ($/unit)

Because duct testing and sealing is a service measure, the base case material cost is $0.00.

Measure Case Material Cost ($/unit)

The measure case material and labor cost for residential duct testing and sealing were drawn from 2010-2012 WO017 Ex-Ante Measure Cost Study conducted by Itron, Inc.[[19]](#footnote-20) This study reports costs for a “typical” duct sealing measure and does not distinguish between “high to low” and “medium to low” leakage as is defined for this measure. Therefore, the material cost for both measure offerings are assumed to be the same. The equipment cost documented in this study was developed from data from two direct installation contractors and benchmarked against RSMeans data.

The cost data were updated to 2020 values using RSMeans Historical Cost Index. The RSMeans Historical Cost Index can be used to compare costs of projects between different cities and years. The ratio of cost indexes provides the percent change expected in the price between the specified years. A comparison of the cost indexes for 2012 and 2020 for Los Angeles (207.2 and 251.5, respectively) reveals a cost increase of 21.4%. This percentage increase value was applied to the WO017 data to reflect 2020 costs.

Finally, duct sealing costs per dwelling are converted to system capacity tons. The average system capacity is based upon a single family residence and is weighted by climate zone and vintage. Inputs to develop the measure case material costs are specified below.

The rNCGF cost is based on the table “Ratio of Res Heat/Cool Cap, kBtuh/ton” provided by CPUC on 11/19/2020.

Measure Case Material and Labor Cost Inputs

|  |  |  |
| --- | --- | --- |
| **Input** | **Value** | **Source** |
| Duct sealing material cost ($/dwelling) | $71.45 | Itron, Inc. 2014. *2010-2012 WO017 Ex Ante Measure Cost Study Final Report.* Prepared for the California Public Utilities Commission. |
| Duct sealing labor cost ($/dwelling) | $181.24 |
| Price index adjustment (%) | 21.4% | Gordian. (n.d.) “RSMeans Cost Index.pdf.” |
| Average system capacity (tons/dwelling) | 3.27 | Program data (proprietary). |

**Measure Case Material and Labor Cost Outputs**

|  |  |  |  |
| --- | --- | --- | --- |
| **Measure Description** | **Material Cost ($/ton)** | **Labor Cost ($/ton)** | **Total Cost ($/ton)** |
| Duct Seal | $26.52 | $67.29 | $93.81 |
| **rNCGF only** | **Material Cost ($/kBTUh)** | **Labor Cost ($/kBTUh)** | **Total Cost ($/kBTUh)** |
| Duct Seal | $1.50 | $3.81 | $5.31 |

Base Case Labor Cost ($/unit)

Because duct testing and sealing is a service measure, the base case labor cost is $0.

Measure Case Labor Cost ($/unit)

See Measure Case Material Cost.

Net-to-Gross (NTG)

The net-to-gross (NTG) ratio represents the portion of gross impacts that are determined to be directly attributed to a specific program intervention. The NTG value for this measure, documented in the DEER Database 2011 Update study conducted by Itron, Inc., can be traced to the 2008 version of DEER. While the *original* source of this NTG value remains unknown, an evaluation of the 2006 – 2008 California programs estimated NTG for residential duct sealing that varied across the investor-owned utility programs from 0.54 to 0.96.[[20]](#footnote-21)

Net-to-Gross Ratios

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Value** | **Source** |
| NTG | 0.55 | DEER2019 - exante database tables: NTG2020 - Res-Default>2 |

Gross Savings Installation Adjustment (GSIA)

The gross savings installation adjustment (GSIA) rate represents the ratio of the number of verified installations of the measure to the number of claimed installations reported by the utility. This factor varies by end use, sector, technology, application, and delivery method. This GSIA rate is the current “default” rate specified for measures for which an alternative GSIA has not been estimated and approved.

This default GSIA is supported by the HVAC sector impact evaluation for program year 2018[[21]](#footnote-22) which showed a gross realization rate (GRR) of 98% for electric kWh and 130% for natural gas therms, and has been directed for use by the CPUC.[[22]](#footnote-23)

Gross Savings Installation Adjustment Rates

|  |  |  |
| --- | --- | --- |
| **Parameter** | **GSIA** | **Source** |
| Def-GSIA | 1.0 | California Public Utilities Commission (CPUC), Energy Division. 2013. *Energy Efficiency Policy Manual Version 5*. Page 31. |

Non-Energy Impacts

Non-energy impacts for this measure have not been quantified.

DEER Differences Analysis

This section provides a summary of inputs and methods from the Database of Energy Efficient Resources (DEER), and the rationale for inputs and methods that are not DEER-based.

Table 1. DEER Difference Summary

|  |  |
| --- | --- |
| **DEER Item** | **Comment / Used for Workpaper** |
| Modified DEER methodology | No |
| Scaled DEER measure | No |
| DEER Base Case | n/a |
| DEER Measure Case | n/a |
| DEER Building Types | Yes |
| DEER Operating Hours | n/a |
| DEER eQUEST Prototypes | n/a |
| DEER Version | DEER2021 (Res\_Duct-Sealing\_NormUnit=kBtuh\_rNCGF\_2020-11-19.xlsx) |
| Reason for Deviation from DEER | n/a |
| DEER Measure IDs Used | Res-DuctSeal-HighToLow-wtd  Res-DuctSeal-MedToLow-wtd |
| NTG | The NTG of 0.55 is associated with NTG ID: *Res-Default>2* |
| GSIA | DEER2011. The GSIA value of 1.0 is associated with GSIA ID: *Def-GSIA* |
| EUL/RUL | The value of 3 years is associated with EUL ID: BRO-RCx*.*  The value of 18 years is associated with EUL ID: *BW per E-5082.* |

Revision History

Measure Characterization Revision History

|  |  |  |  |
| --- | --- | --- | --- |
| **Revision Number** | **Date** | **Primary Author, Title, Organization** | **Revision Summary and Rationale for Revision**  **Effective Date and Approved By** |
| 01 | 06/30/2018 | Jennifer Holmes  Cal TF Staff | Draft of consolidated text for this statewide measure is based upon:  SCE17HC029, Revision 1 (May 22, 2018)  PGE3PHVC159, Revision 5 (June 2, 2017)  PGE3PHVC159, Revision 4 (December 1, 2016)  PGE3PHVC159, Revision 2 (March 9, 2015)  Consensus reached among Cal TF members. |
|  | 04/29/2019 | Adan Rosillo, PG&E  Jennifer Holmes  Cal TF Staff | Revisions for submittal of version 01. |
|  | 07/02/2019 | Ayad Al-Shaikh, Cal TF Staff | Update DEER IDs |
| 02 | 09/18/2020 | Phil Jordan,  CLEAResult  Tai Voong, PG&E | Update per Resolution E-5082 (MAT & EUL) & CPUC’s comments.  DMo & pre-vintages of 2006 for SFm & MFm  (MAT=BW, EUL=18 years, & EUL ID=HV-DuctSeal-BW)  2006 & post-vintages of 2006 for SFm &MFm  (MAT= BRO-RCx, EUL=3 years, & EUL ID=HV-DuctSeal)  Update energy impact for Res-DuctSeal-HighToLow-wtd & Res-DuctSeal-MedToLow-wtd by DEER dated September 2020  Update cost using RSMeans Cost Index  DEER data energy impact 9/17/2020 |
| 03 | 12/11/2020 | Tai Voong, PG&E | Update per CPUC Comments on 10/5/2020  Use 2021 DEER energy impact data released on 11/19/2020  Add measure codes for rNCGF |
|  | 03/19/2021 | Lake Caso, PE  TRC  Tai Voong,  PG&E | Update per CPUC Comments on 2/4/2021  Use “Old” vintage savings for BW measures for SFm, MFm, and DMo buildings  Added eligibility requirements for duct sealing materials per E-5082, clarified duct testing type requirements, and vintage eligibility  Added data collection for installations  Adopted Def-GSIA value based on PY2018 EM&V report |
|  | 05/28/2021 | Tai Voong, PG&E | Change Revision 02 to Revision 03 per CPUC. |

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