**WORKPAPER DISPOSITION FOR**

**Residential HVAC Quality Maintenance**

**California Public Utilities Commission, Energy Division**

May 2, 2013

Refer to Table 1 for a list of currently submitted IOU workpapers that cover Residential HVAC Rooftop Quality Maintenance (QM) as part of statewide programs. list workpapers covered by this disposition in terms of their measure categories. The embedded workbook, *“20132014-ResidentialHVACMaintenanceDisposition-April2013-v1-2.xlsx”,* includes staff approved savings values for individual treatments as well as combined savings values for comprehensive HVAC QM measures. As much as possible, savings categories match those in the original work papers. The treatment-based values in this disposition have been applied to both the state-wide and local programs. That is, this document provides a uniform statewide disposition for all workpapers listed in .

Table 1 - Residential HVAC Quality Maintenance Workpapers

|  |  |  |
| --- | --- | --- |
| **Workpaper ID** | **Workpaper Title** | **Date Submitted** |
| **SDG&E** |  |  |
| WPSDGEREHC1065 | Residential HVAC Quality Maintenance and Motor Retrofit | 6/26/2012 |
| **SCE** |  |  |
| SCE13HC039 | Residential HVAC Quality Maintenance and Evaporator Motor Retrofit | 5/29/2012 |
| SCE13HC028 | Brushless Fan Motor for Residential Central AC | 4/13/2012 |
| **PG&E** |  |  |
| PGECOHVC139 | Residential HVAC Quality Maintenance | 8/29/2012 |

**Workpaper Disposition:** Approved Pending the Following Revisions

1. Revise Ex-Ante Claims Process: Commission staff prefers that ex ante claims be based on the actual service tasks completed as part of the QM process. Claim categories and savings should match those currently used to provide compensation to service providers. IOUs disagree with this approach and say that this process would be difficult to implement in their reporting systems. Staff prefers that ex-ante claims are to be based upon the service provider incentive structure in three broad categories as outlined in Table 2. Note that a specific service incentive does not necessarily correspond directly to all related workpapers in the adjacent column. This table addresses both the statewide, local and 3rd party programs.

Table 2 – Workpaper Listing by Measure Category

|  |  |  |
| --- | --- | --- |
| **Measure Category** | **Service Incentive** | **Related Workpapers** |
| RCA | Adjust Airflow | WPSDGEREHC1065 |
| Refrigerant System Service | SCE13HC039 |
| Condenser Coil Cleaning | PGECOHVC139 |
| Evaporator Coil Cleaning | WPSDGERERN001 |
| Duct Test and Seal | Test and Seal Ductwork | WPSDGEREHC1065 |
| SCE13HC039 |
| PGECOHVC139  WPDUCTSEAL2009 |
| Supply Blower Motor Retrofit | Supply Blower Motor Retrofit | WPSDGEREHC1065 |
| SCE13HC039 |
| PGECOHVC139 |
| SCE13HC028 |

1. Revise All Unit Energy Savings (UES) Values: UES values shall be obtained from the attached workbook “*20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*.”

Commission staff developed these values considering the following:

* + Projected savings for many of the components of the QM programs remain difficult to obtain because skilled maintenance technicians are required to realize anticipated program benefits. The use of incorrect maintenance techniques, test and repair equipment, and procedures can result in a decrease in cooling system efficiency and/or increase in system operation – both generating negative energy savings. These are not only undesired results, but act to offset benefits obtained at properly maintained sites.
  + All UES values should be based on published DEER values where at all possible. In addition, the use of those values must account for the DEER applicability limits when they occur. An example is refrigerant charge adjustment. Published DEER values accrue only if the addition or removal of refrigerant charge equals or exceeds 10% on the unit’s nominal total refrigerant charge.
  + The *Restore and Improve Duct System Insulation* treatment is not approved. Commission staff finds there are not adequate field data to support this measure at this time. This measure can reinstated if reasonable data are provided to support savings assumptions. The *Refurbish Duct* treatment is allowed with savings based upon air flow adjustments in the attached UES workbook “*20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx*” as discussed in Attachment A.

1. Installation Rates Must be Considered in Calculation of the Overall Savings: The Commission has published installation rates for refrigerant charge adjustment (RCA) and Duct Sealing measures. However, the installation rate for all other measures is assumed to be 1. Therefore, the overall savings of the QM package must be calculated as the sum-product of individual savings values times their respective installation rates times their expected incidence fractions. This calculation is included in the workbook “*20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.”*
2. EUL Shall be 5 years: The EUL shall be 5 years, which is the RUL of package equipment being treated.
3. NTG Shall be 0.70: The NTG shall be 0.70, which is the DEER value for all other residential measures with moderate market share and no convincing strategies to discourage free ridership.
4. Blower Replacement Disposition is Included in Attachment C: Refer to Attachment C for complete disposition on blower motor replacement measures.

**Background for Workpaper Treatment-Specific Dispositions**

Commission staff believes that the proposed ex ante values are overly optimistic. These concerns have been voiced in past workpaper reviews and project coordination reviews. They include baseline issues that are not fully supported, savings assumptions that remain in question, and program implementation issues that have the potential to adversely affect program benefits. Staff understands the time and effort required to fully implement these programs, and this review is based on staff’s best evaluation of the programs’ current ability to deliver savings.

A review of baseline assumptions used in the estimation of ex ante savings is believed to be overly pessimistic in the relative occurrence of faults. These concerns were outlined specifically in the disposition of the SCE 2010-2012 QM workpaper and in coordination meetings with PG&E. The assumed treatment weightings used to combine treatment savings values are provided in the HVAC QM Savings tab in the combined savings workbook – “*20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx.”* Refer to cells Q4 through D9 in the “*Res\_HVAC-QM\_Savings”* tab for the values staff has used for the expected incidence of treatment.

The following attachments provide details on the assumptions and base values used to produce accepted UES values and their associated installation rates. Each attachment details the source of UES values, application of IR values, accepted net-to-gross values and appropriate EUL values.

* Attachment A - Background for RCA Related UES Values. This attachment details the development of UES and installation rate values for refrigerant charge adjustment, condenser and evaporator coil cleaning, and air flow adjustment tasks.
* Attachment B - Background for Duct Testing and Sealing (DTS) Related UES Values. This attachment details the development of UES and installation rate values for duct test and seal treatments.
* Attachment C - Background for Residential Blower Motor Replacement UES Values. This attachment details the development of UES values for the replacement of supply air blower standard permanent split capacitor (PSC) motors with more efficient brushless permanent magnet (BPM) motors.

**Attachment A - Background for Residential RCA Related UES Values:**

Savings estimates for workpapers that include refrigerant charge and air-flow adjustment related claims differ significantly in their approaches to determining those claim values. Rather than examining each workpaper and approach separately, this disposition provides a single set of values based on those provided in the 2011 DEER database.

It is important to note that current DEER UES values represent program end goals that could be obtained via a properly functioning maintenance program. Cooling system efficiency improvements used to generate these savings were obtained by a cadre of skilled technicians focused on maximizing system efficiency improvements. These same technicians currently serve as master technicians in the ongoing program EM&V effort. Commission staff believes that service technicians of this level of expertise operate in IOU-sponsored QM efforts, however Commission staff also believes a significant quantity of service technicians do not possess a master’s level of expertise, and program benefits suffer as a result.

The general approach in establishing task-based UES values includes the following steps:

1. Start with UES values from the 2011 DEER database for commercial RCA efforts. Again, these values are viewed as a realizable goal for all QM efforts.
2. Separate those values into task components of charge adjustment, condenser and evaporator coil cleaning and air flow adjustment.
3. Provide adjustments to the various components to account for proper application of DEER assumptions and installation rates that represent best estimates of the current state of programs in obtaining DEER values.
4. **DEER RCA Data**

DEER savings estimates used as a starting point in this portion of the disposition are based on 2011 DEER ID *Res-RefrigCharge-wtd.* These values were developed by weighting the four individual refrigerant charge measures (high overcharge, typical overcharge, high undercharge, typical undercharge) for the “existing” building vintage. Where building weights did not include populations for a particular IOU and climate zone, statewide weightings for the climate zone were used. These provide savings estimates for all residential building types across all IOUs and climate zones.

The assumptions and data associated with the DEER values are well documented in the 2005 DEER Update Study. The assumptions concerning efficiency improvements associated with an RCA effort are unchanged in DEER 2011; only prototype building models may have changed. The data used in DEER to provide measure savings for refrigerant system repairs are the same as those used in the residential QM analyses for workpapers WPSDGEREHC1065, SCE13HC029 and PGECOHVC139.

1. **Calculating Charge Versus Non-Charge Related Services**

The QM workpapers recognize that savings estimates arise from a mix of treatments – not just a charge adjustment. Potential treatments include refrigerant charge adjustment, condenser and evaporator coil cleaning, air flow adjustments and other fault corrections like removal of non-condensables or line restrictions in the refrigerant system. Unfortunately, the actual tasks performed that generated those savings were not published, nor were the incremental benefits of various treatments measured. The approach taken in IOU workpaper development efforts was to assume that efficiency improvements associated with minimal charge adjustments (less than ±10% change in charge) were all a result of coil cleaning and air flow adjustments. While this approach has merit, some efficiency benefits noted in the data set exceeded that which would normally accrue from these remedies and are likely a result of fault corrections that are not included in current QM programs. Examples of faults not included in current QM programs are the elimination of non-condensables and/or liquid line restrictions in the refrigerant system.

Staff estimate that non-charge related services may account for an additional 25% savings on top of RCA. Based on this assessment, published DEER benefits are segregated into charge adjustment and non-charge adjustment remedies as follows:

Gross Charge Adjustment Savings = DEER values (1)

Gross Non-Charge Adjustment Savings = DEER values \* 0.25 (2)

1. **Charge Adjustment Savings Modifier – Baseline Adjustment**

The DEER values used in Equation 1 are weighted values that accrue only for charge adjustments greater that 10% of unit nominal charge. The DEER UES values are a simple weighting of original savings estimates based on low and high charge adjustments whose minimum charge adjustment threshold is ±10%. Current programs do not include charge level as a savings accrual requirement. This disposition addresses this by applying a multiplier to charge-related DEER values from Equation 1 to account for the number of systems that will receive a charge adjustment in the program, but are below the threshold needed to generate significant energy savings.

Figure 1 provides the distribution of units from which DEER impacts are evaluated based on the charge adjustment for each unit.[[1]](#footnote-1) Based on the data collected, 45% of all serviced units had charge adjustments less than 10%. No significant energy savings related to charge adjustment occurs for those units. From this, when the level of charge adjustment is ignored, the charge adjustment savings (based on values in the 2011 DEER) must be reduced by the number of units for which no significant savings are expected. In consideration of values from Figure 1 as well as the possibility that some refrigerant charge adjustments may result in increased energy use, staff has assigned an incidence fraction of 0.40 to savings values for RCA.

Figure - Unit Distribution by Charge Adjustment Level



In addition to the expected incidence occurrence for refrigerant charge adjustments, a standard installation rate of 0.568 shall be applied to all refrigerant charge measures. This is the statewide value included in READI for residential refrigerant charge measures. For third party and local RCA programs, the installation rate is a separate entry for each claim. For statewide QM programs, the installation rate is included in the calculation of the overall savings for each QM claim. This is necessary since installation rate values for each treatment within the QM program vary and must be included in the savings calculation. Then, since the claimed savings for the QM program will include installation rate adjustments for each of the contributing measures, the claimed installation rate for QM claims shall be 1.

1. **Non-Charge Adjustment Savings Modifiers:**

There is no known evidence as to the relative impact from the three measures – condenser coil cleaning, evaporator coil cleaning and air flow adjustment - that generate non-charge adjustment savings. It is generally recognized that typical efficiency improvements associated with condenser coil cleaning is much larger than the other two. Given a paucity of direct measurements of field conditions, Commission staff recommends the following apportioning of non-charge adjustment savings among the three possible measures:

Condenser Coil Cleaning: 50% of the total

Evaporator Coil Cleaning: 25% of the total

Air Flow Adjustment: 25% of the total.

In addition to the fractions described above, staff also assigns the following incidence fractions to the gross savings results:

Condenser Coil Cleaning: 0.80

Evaporator Coil Cleaning: 0.60

Air Flow Adjustment: 0.60

1. **Final Savings Values for Individual Measures:**

The approved UES values for RCA and related measures are included in the embedded workbook “*20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx”* in the following tabs:

Refrigerant Charge Adjustment: *DEER2011-RefrigCharge-Wtd*

Condenser Coil Cleaning: *ResCondCoilCleaning*

Evaporator Coil Cleaning: *ResEvapCoilCleaning*

Air Flow Adjustment: *ResAirFlowAdjust*

**Attachment B - Background for Residential DTS Related EUS Values:**

UES values for the DTS are taken directly from DEER. There are two measures in DEER, one for high initial duct leakage (measure ID *Res-DuctSeal-HighToLow-wtd*) and medium initial duct leakage (measure ID *Res-DuctSeal-MedToLow-wtd*). Disposition UES values are the weighted average of those provided in the two measures. Additionally, staff assigns the following incidence factors:

High initial leakage: 0.14

Medium initial leakage: 0.39

The statewide installation rate for DTS measures from the 2006-2008 evaluations is 0.463. This essentially means that more than half the installations have no benefit, even if, on those installations, some amount of duct sealing was performed that did not result in requisite reduction in duct leakage. In consideration of partial benefits as well as the likelihood that utilities have instituted improvements to installation and verification, staff believe that the installation rate should be increased by 50%, according to the following equation:

IRadj = 0.463 + 0.50 \* ( 1 – 0.463 ) = 0.73

Given the lack of precision in the analysis of installation rates, staff has used an installation rate of 0.75 for DTS measures.

**Attachment C - Background for Residential Blower Motor Replacement EUS Values:**

Base UES values for the supply air blower motor replacement are taken from QM workpaper supporting documents. Savings are for single family air conditioning systems with gas heat only. Other residential building types or HVAC systems are not covered. Savings are by climate zone alone and are the same across all IOUs.

1. **Savings Adjustments**

Staff believes the data upon which savings are estimated is limited, may not apply to California HVAC systems and does not account for the limits of the technology. Specifically, workpaper UES values do not account for the declining efficiency difference between standard PSC and measure BPM motors as motor capacity increases. This disposition adjusts savings values from those provided in workpapers as described below. Savings calculations are included in the attached workbook *20132014ResBlowerRaplacementDisposition-v1-2.xlsx.*

1. Energy Division claims that the efficiency difference between PSC and BPM motors falls to zero as the motor rated capacity reaches 1 horsepower (hp). Efficiency differences provided in the workpapers are acceptable for motors with capacities of ½ hp or less.
2. The supply air blower motor capacity by unit nominal cooling capacity assumed by Energy Division is provided in Table C.1.

Table C. - Assumed Supply Air Blowr Motor Horsepower

|  |  |
| --- | --- |
| Capacity | hp |
| ≥ 3.5 tons | 1/2 |
| 4 tons | 3/4 |
| 5 tons | 1 |

1. Energy Division assumes the efficiency differences between PSC and BPM ¾ hp motors is assumed to produce half the savings claimed in workpapers. The PSC and BPM 1 hp motors are assumed to operate at the same efficiency.
2. The distribution of nominal cooling capacities for residential cooling systems was estimated from the database of units in the 2006-2008 evaluation of air conditioner replacement programs. Other program evaluation data were examined for RCA and DTS, but much of it was for multi-family sites not covered by the QM programs. From the 2006-2008 data, the distribution of units by nominal cooling capacity is provided in Table C.2.

Table C. - Distribution of Cooling Equipment by Nomincal Cooling Capacity

|  |  |
| --- | --- |
| Capacity | hp |
| ≥ 3.5 tons | 50.9% |
| 4 tons | 30.3% |
| 5 tons | 18.8% |

1. Based on the distribution of units provided in Table 2, and the assumed efficiency declines noted in Item 3, Energy Division believes that workpaper UES values should be reduced by 33.9%. This assumes that there are only ½ the benefit for 30.3% of the motors replaced (4 ton units) and no benefit for 18.8% of the motors replaced (5 ton units).
2. **EUL:** The blower motor is an addition to an existing system. Program rules limit the EUL of maintenance on an existing system to no more than system’s RUL. By rule, this is 1/3 of the 15 year EUL for direct expansion HVAC system, or 5 years.
3. **Net-to-Gross:** The NTG shall be 0.70, which is the DEER value for all other residential measures with moderate market share and no convincing strategies to discourage free ridership.

**References**

Residential HVAC Maintenance Savings Values



Residential HVAC Indoor Fan Motor Replacement Savings Values



1. p. 1-212, Mowris, Robert J., Anne Blankenship and Ean Jones, Robert Mowris & Associates, “Field Measurements of Air Conditioners with and without TXVs”, 2004 ACEEE Summer Study Proceedings. [↑](#footnote-ref-1)