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HVAC

SWSV009-01 AIR FLOW ADJUSTMENT, RESIDENTIAL

CONTENTS

MEASURE NAME

Air Flow Adjustment, Residential

STATEWIDE MEASURE ID

SWSV009-01

TECHNOLOGY SUMMARY

Proper maintenance of an air conditioner (AC) or heat pump HVAC equipment will enable the equipment to operate at or near its optimal efficiency. Quality maintenance (QM) measures are treatments designed to increase the effectiveness of HVAC equipment to deliver heating and cooling and increased thermal comfort.

The level of maintenance by technicians on a typical AC or heat pump unit is minimal with service being performed at an unacceptable level. This may eventually lead to unit failure and/or poor performance, forcing premature equipment replacement. In response to this problem, Air Conditioner Contractors of America (ACCA) developed Standard 4 for "Maintenance of Residential HVAC Systems".[1]

The impact evaluation of 2015 commercial quality maintenance programs (HVAC3) conducted by DNV GL[2] analyzed the impacts of three residential measures implemented through the QM programs: coil cleaning, supply fan, and refrigerant charge adjustment – RCA (as well the five commercial measures with the highest claimed savings across the QM programs). The specific programs evaluated were Residential QM (PG&E, SDG&E), Commercial QM (PG&E), AirCare Plus (PG&E), QM (SCE and SoCalGas), Deemed (SDG&E), and Direct Install (SDG&E).

MEASURE CASE DESCRIPTION

This measure is defined as an air flow adjustment designed to increase the unit's ability to deliver heating and cooling efficiently and to provide increased thermal comfort. This may include adjusting of diffusers, dampers, or registers to optimize airflow performance in the system.

BASE CASE DESCRIPTION

The base case for this measure is defined as a standard non-treated HVAC system.

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[1] Air Conditioning Contractors of America (ACCA). 2013. *Maintenance of Residential HVAC Systems*. ANSI/ACCA Standard 4 QM – 2013.

[2] DNV GL. 2017. *Impact Evaluation of 2015 Commercial Quality Maintenance Programs (HVAC3)*. Prepared for the California Public Utilities Commission. April 7.

CODE REQUIREMENTS

This measure is not governed by federal or state appliance or building standards. The California Building Energy Efficiency Standards (Title 24) does not deal with quality maintenance (QM) treatments. Notably, the California mechanical code states that changes, alterations, or repairs of a minor nature that do *not* affect structural features, egress, sanitation, safety, or accessibility as determined by the enforcing agency are exempt from the requirement to obtain a mechanical permit.

Note, however, the program requires the HVAC contractor to be licensed by the California State Licensing Board (CSLB) and that HVAC technicians are certified by the U.S. Environmental Protection Agency (EPA).

Applicable State and Federal Codes and Standards

Code	Applicable Code Reference	Effective Date
CA Appliance Efficiency Regulations – Title 20 (2019)	None	1/1/2019
CA Building Energy Efficiency Standards – Title 24 (2019)	None	1/1/2020
Federal Standards	None	n/a

NORMALIZING UNIT

Tons of cooling capacity (Cap-Tons)

PROGRAM REQUIREMENTS

Measure Implementation Eligibility

All measure application type, delivery type, and sector combinations 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.

Implementation Eligibility

Measure Application Type	Delivery Type	Sector
BRO-RCx	Direct Install	Res
BRO-RCx	Down-Stream Incentive	Res
BRO-RCx	Up-Stream Incentive	Res

Note: Up-Stream Incentive is being left as an approved Delivery Type to enable Midstream offerings.

Eligible Products

The following prerequisites must be met before the Quality Maintenance (QM) treatments, such as air flow adjustments, can be implemented:

- 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 ACCA Standard 4[3] prior to any treatments being applied to determine the baseline conditions and to develop QM treatment recommendations.
- The customer must agree to a QM Service Agreement.

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.

The level of maintenance by technicians on a typical air conditioner or Heat Pump equipment is minimal with service being performed at an unacceptable level. This may eventually lead to unit failure and/or poor performance, forcing premature equipment replacement. In response to this problem, Air Conditioner Contractors of America (ACCA) developed Standard 4 for "Maintenance of Residential HVAC Systems"[4]. For the measures contained in this work paper, an assessment and report is required in accordance with ACCA Standard 4 prior to any treatments being applied to determine the baseline conditions and to develop treatment recommendations.

Eligible Building Types and Vintages

This measure is applicable for residential single family, multifamily, and double-wide mobile homes that use central air-cooled direct expansion (DX) cooling and gas heating.

Eligible Climate Zones

This measure is applicable in all California climate zones.

PROGRAM EXCLUSIONS

None.

DATA COLLECTION REQUIREMENTS

Data requirements are to be determined.

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[3] Air Conditioning Contractors of America (ACCA). 2013. *Maintenance of Residential HVAC Systems*. ANSI/ACCA Standard 4 QM – 2013.

[4] Air Conditioning Contractors of America (ACCA). 2013. *Maintenance of Residential HVAC Systems*. ANSI/ACCA Standard 4 QM – 2013.

USE CATEGORY

HVAC

ELECTRIC SAVINGS (kWh)

The electric unit energy savings (UES) of air flow adjustments of residential air conditioning (AC) units were derived from impacts in the Database of Energy Efficient Resources (DEER). The DEER version used to calculate savings for these measures is DEER 2020 in addition to RQM Savings Disposition[5]. The results were reported in the Remote Ex-Ante Database Interface (READI) tool v2.5.1.

The UES of this air flow adjustment measure were derived using the Disposition's recommended contributions as a function of the DEER 2020 Adjusted Refrigerant Charge measure (Measure ID: *Res-RefrigCharge-wtd*),[5] (See "ResAirFlowAdjust" tab) in conformance with the "Workpaper Disposition for Residential HVAC Quality Maintenance" issued by the California Public Utilities Commission (CPUC) Energy Division[5].

Air Flow Adjustment measure savings impacts were calculated as a fraction of the Refrigerant Charge Adjustment (Res-RefrigCharge-wtd). As done in the Disposition the fraction value of 0.0625 is used to adjust the savings, based on expected contributions of non-charge adjustment savings and incidence fractions.

$$UES_{airflow} = 0.0625 * UES_{Res-RefrigCharge-Wtd}$$

PEAK ELECTRIC DEMAND REDUCTION (kW)

The peak demand reduction of air flow adjustments of residential air conditioning (AC) units were derived from impacts in the Database of Energy Efficient Resources (DEER). The DEER version used to calculate savings for these measures is DEER 2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool v2.5.1.

The peak demand reduction of this air flow adjustment measure was derived as a function of the refrigerant charge adjustment (RCA) measure in DEER (Measure ID: *Res-RefrigCharge-wtd*),[6] (See "ResAirFlowAdjust" tab) in conformance with the "Workpaper Disposition for Residential HVAC Quality Maintenance" issued by the California Public Utilities Commission (CPUC) Energy Division in May 2013.[6]

Air Flow Adjustment measure savings impacts were calculated as a fraction of the Refrigerant Charge Adjustment (Res-RefrigCharge-wtd). A fraction value of 0.0625 was used based on referenced CPUC's

[5] California Public Utilities Commission (CPUC), Energy Division. 2013. "20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx"

[6] California Public Utilities Commission (CPUC), Energy Division. 2013. "20132014-ResidentialHVACMaintenance-SavingsValues-April2013-v1-2.xlsx"

disposition.

$$Demand\ Reduction_{\ airflow} = 0.0625 * Demand\ Reduction_{Res-RefrigCharge-Wtd}$$

GAS SAVINGS (THERMS)

The gas unit energy savings (UES) of air flow adjustments of residential air conditioning (AC) units were derived from impacts in the Database of Energy Efficient Resources (DEER). The DEER version used to calculate savings for these measures is DEER 2020. The results were reported in the Remote Ex-Ante Database Interface (READI) tool v2.5.1.

The UES of this air flow adjustment measure were derived as a function of the refrigerant charge adjustment (RCA) measure in DEER (Measure ID: *Res-RefrigCharge-wtd*)[6], (See "ResAirFlowAdjust" tab) in conformance with the "Workpaper Disposition for Residential HVAC Quality Maintenance" issued by the California Public Utilities Commission (CPUC) Energy Division in May 2013[7].

Air Flow Adjustment measure savings impacts were calculated as a fraction of the Refrigerant Charge Adjustment (Res-RefrigCharge-wtd). A fraction value of 0.0625 was used based on referenced CPUC's disposition.

$$UES_{airflow} = 0.0625 * UES_{Res-RefrigCharge-Wtd}$$

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.

As per Resolution-4952[8], the California Public Utilities Commission (CPUC) created the Behavioral Operational Retrocommissioning (BRO-RCx) measure classification and also noted that the original EUL ID "HV-ResRCx" is no longer applicable. As the measure savings are estimated based on a refrigerant change impact, the EUL for the refrigerant change RCx measure ("HV-RefChrg") is used for the EUL and RUL values shown below.

[7] California Public Utilities Commission (CPUC), Energy Division, Ex Ante Review Team. 2013. "Workpaper Disposition for Residential HVAC Quality Maintenance." May 2.

[8] California Public Utilities Commission (CPUC), Energy Division. 2018. *DEER resolution E-4952.* 11 October 2018

Effective Useful Life and Remaining Useful Life

Parameter	Value	Source
EUL (yrs) (HV-RefChrg)	3	California Public Utilities Commission (CPUC), Energy Division. 2018. *DEER resolution E-4952.* 11 October 2018. Table 8
RUL (yrs)	0	California Public Utilities Commission (CPUC), Energy Division. 2019. *DEER resolution E-5009.* 12 September 2019

BASE CASE MATERIAL COST ($/UNIT)

The base case is defined as the existing equipment; thus, the base case material cost is $0.00.

MEASURE CASE MATERIAL COST ($/UNIT)

The measure case material cost for this measure is $0.00 because this measure only involves labor does not require the purchase of equipment or materials.

BASE CASE LABOR COST ($/UNIT)

The base case is defined as the existing equipment; thus, the base case labor cost is $0.00.

MEASURE CASE LABOR COST ($/UNIT)

The material case labor costs were drawn from the 2018 RSMeans Mechanical Cost Data[9] (see "Rooftop heating and cooling unit – air balance"). Specifically, the labor cost for this air flow adjustment measure is assumed to equal the labor cost for air balance of a package air conditioner (AC). RSMeans data is provided on a per AC unit basis, thus the RSMeans cost was divided by the average tonnage for a residential housing unit. The average tonnage of 3.78 tons was derived based on 2018 SCE residential refrigerant charge programs consisting of 24,457 existing residential households.[10] Future updates to this data set from other IOUs may require adjustment to the average tonnage value used in the calculation.

Inputs to derive the measure case material cost are specified below.

Measure Case Labor Cost Inputs

Input	Value	Source
Air balance of a package AC unit ($/AC unit)	$350.00	2018 RSMeans Mechanical Cost Data
Average capacity per single family household (tons)	3.78	Southern California Edison 2018 Residential Refrigerant Charge Dataset "SWSV009-01 SCE 2018 Refrigerant Adjustment Program Data.xlsx"

[9] 2018 RSMeans Mechanical Cost Data

[10] Southern California Edison 2018 Residential Refrigerant Charge Dataset. "SWSV009-01 SCE 2018 Refrigerant Adjustment Program Data.xlsx"

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. This sector average NTG ("default NTG") is applicable to all energy efficiency measures that have been offered through residential sector programs for more than two years and for which impact evaluation results are not available. Resolution E-4952 provides the DEER2020 updated NTG values for airflow adjustment under the "All Other Residential HVAC Maintenance" measure column of Table 7.

Net-to-Gross Ratios

Parameter	Value	Source
Res-Default>2	0.55	California Public Utilities Commission (CPUC), Energy Division. 2018. *DEER resolution E-4952.* 11 October 2018. Table 7

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. The specified GSIA is in conformance to the installation rate specified by the California Public Utilities Commission (CPUC) Energy Division in the "Workpaper Disposition for Residential HVAC Quality Maintenance" issued in May 2013.

Gross Savings Installation Adjustment Rates

Parameter	Value	Source
GSIA – Residential Refrigerant Charge & Air Flow Adjustment (Res-RCA-All)	0.568	California Public Utilities Commission (CPUC), Energy Division, Ex Ante Review Team. 2013. "Workpaper Disposition for Residential HVAC Quality Maintenance." May 2. Page 7.

NON-ENERGY IMPACTS

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

DEER DIFFERENCES ANALYSIS

This section provides a summary of DEER-based inputs and methods, and the rationale for inputs and methods that are not DEER-based.

DEER 2020 contains quality maintenance (QM) treatments as standalone measures, with the assumption that all other features of the prototype are held constant at an energy efficient baseline; the standalone measures are: refrigerant charge and adjustment, duct sealing, refrigerant charge with duct sealing, and condenser and evaporator coil cleaning. All measure impacts were derived from DEER2020 in

conformance with the "Workpaper Disposition for Residential HVAC Quality Maintenance" issued by the California Public Utilities Commission (CPUC) Energy Division in May 2013 (May 2013 RQM Disposition).[11].

DEER Difference Summary

DEER Item	Comment / Used for Workpaper
Modified DEER methodology	Yes (as noted)
Scaled DEER measure	Yes – impacts of air flow adjustment measure based upon scaled refrigerant charge measure impacts
DEER Base Case	Yes
DEER Measure Case	Yes
DEER Building Types	Yes
DEER Operating Hours	Yes
DEER eQUEST Prototypes	No
DEER Version	DEER2020
Reason for Deviation from DEER	Disposition to DEER and Resolution E-9521
DEER Measure IDs Used	Res-RefrigCharge-wtd
NTG	Source: DEER. The NTG of 0.55 is associated with NTG ID: *Res-Default>2*
GSIA	Source: DEER. The GSIA of 0.568 is associated with GSIA ID: *Res-RCA-All*
EUL/RUL	Source: 2018 Resolution E-4952. EUL and RUL values of 3 and 1 years were assumed based on the residential refrigerant charge that is referenced for savings estimates. 2019 Resolution E-5009. RUL value for BRO measures corrected to 0 years.

[11] California Public Utilities Commission (CPUC), Energy Division, Ex Ante Review Team. 2013. "Workpaper Disposition for Residential HVAC Quality Maintenance." May 2.

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	09/30/2018	Jennifer Holmes Cal TF Staff	Draft of consolidated text for this statewide measure is based upon: SCE17HC029, Revision 1 (May 22, 2018) WPSDGERERN001, Revision 3 (December 15, 2017) – short form WPSDGERERN001, Revision 0.1 (July 27, 2014) Consensus reached among Cal TF members.
01	04//2018	Richard Williams TRC Companies	Updated Implementation Eligibility Table Updated to DEER2020 values where applicable Updated DEER2018 savings calculation methodology for Air-Flow Adjustment factor Updated NTG value based on E-4952. Updated EUL and RUL values based on resolution E-4952 and E-5009
01	09/17/2019	Richard Williams TRC Companies	Updated document to reflect DEER 2020 and energy impact savings updates resulting from new weighting methodology.