Residential Quality Installation (RQI) & WO32 HVAC Impact Evaluation

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Presentation Overview

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- RQI Measure Overview
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RQI Measure Objective

- Improve Quality Installation (QI) of mechanical (HVAC) systems in Residential applications
- Improve HVAC system performance with QI
- Improve HVAC system performance with efficiency upgrade
- Savings ~ performance approach [QI + Efficiency (SEER) Upgrade]

RQI Measure Overview

Base Case Description

- T24 Standard (SEER 14) split and packaged HVAC unit (Replace-on-Burnout)
- Oversized HVAC unit
- Low airflow
- Leaky air distribution duct system

Measure Description

- Quality Installation (QI) of Standard (SEER 14) and higher efficiency split and packaged HVAC units
- Properly sized HVAC unit
- Optimized airflow
- Non-leaky (sealed) air distribution duct system

Calculation Method

Performance (single point value) approach using DEER (DOE2.2) prototype

Performance Parameters Informing the Energy Model

QI Measure	Keyword	Description
HVAC equipment sizing	COOLING-CAPACITY; COOL-SH-CAP	ACCA Manual J ACCA Manual S
Air duct leakage	DUCT-AIR-LOSS	Air leakage reduction of total system airflow
Airflow Performance	SUPPLY-KW/FLOW	kW/cfm ~ f(fan power, system airflow, and temp. gain)
Airflow Capacity	SUPPLY FLOW	cfm/ton - stablished using nominal cooling tons per AHRI ratings and measured system airflow
Equipment Efficiency (SEER)	COOLING-EIR	2013 Title-24 Baseline (SEER 14)

WO32 (RQI) Overview

- **Goals**
  - HVAC impact evaluation of statewide programs
  - Field assessments focused on residential systems
- **Field measurements**
  - HVAC system sizing
  - Airflow
  - Duct leakage
- **Energy/Demand savings**
  - Field measurements
  - DEER Prototype eQuest/DOE2.2
- **Participants – SCE (100%)**
- **Non-participants - PG&E, SCE (36%), and SDG&E**

WO32 (RQI) Key Findings

- On average installations exceeded T-24
- Utilities to review program opportunities to exceed T-24
- Support evaluation “to-code” pilots
- WP does address ACCA Manual S to system sizing
- Realization rates:
  - 35% for energy (kWh) savings
  - 38% for demand (kW) savings
  - “Exceeding code will improve realization rates, but it is unknown if cost effective savings exist”
  - Driven by “system sizing” and “duct leakage”

Airflow Performance (kW/cfm)

WP (Base)	WP (Measure)	WO32 (NPart)	WO32 (Part)	SubcTF (Base)	SubcTF (Measure)
0.510 W/cfm	0.383 W/cfm	0.569 W/cfm	0.486 W/cfm	0.580 W/cfm (T24)	0.369 W/cfm

Base Case

- T24 - “it is mandatory that central forced air systems produce fan watt draws less than or equal to 0.580 watts/cfm”
- Consistent with WO32 (Non-Participant)

Measure Case

- 2014-2015 program data - 2,400 jobs throughout SCE’s territories
- Consistent with AHRI 210/240 - 0.365 W/cfm

General Notes
Airflow Performance (kW/cfm)

CALIFORNIA TECHNICAL FORUM

Program Data

- There are 3 methods allowed in the program for measuring air flow including (1) Flow hood at the return; (2) rotating vane 4” anemometer measured at the return; and (3) Flow plates measured at the furnace entrance or the return.
- Estimated system airflow performance (kW/cfm) conservatively assume a PF of 0.78.
- Most new HVAC systems include ECM motors

Air Duct Leakage (%)

WP (Base)	WP (Measure)	WO32 (NPart)	WO32 (Part)	SubcTF (Base)	SubcTF (Measure)
24% (DEER)	12% (DEER)	16.6%	11.5%	29.7% (Non-T24)	10.5%

Base Case

- Program data and T24 requirement per permitted jobs
- **% Leakage = A + B = 29.7%**
  - A = (38% permitted jobs at 15% T24_leakage)
  - B = (62% non-permitted jobs at 38.7% program leakage)
- PGE – "HVAC Permitting: A Study to Inform IOU HVAC Programs, by DNV-GL"

Measure Case

- Program data
- **% Leakage = 10.5%**
- Consistent with WO32 (Participants)

General Notes
Duct Leakage (%)

A. Permitting Rates

- Permitting rates based on PGE's study - **HVAC Permitting: A Study to Inform IOU HVAC Programs**, by DNV-GL dated 10/10/2014.
- "Testimony to the Little Hoover Commission March 27, 2014", referenced in WO32 HVAC evaluation, that suggests lower permitting - 10%.
- WHPA – Communications with contractors suggest "Over 95% of jobs are non-permitted, because the current process has no perceived benefit for consumers"

B. Duct Leakage

Measured using the "Minneapolis duct blaster" at 25 Pa.

C. Energy Modeling Methods

The SubcTF feels that eQuest/DOE2.2 methods for modeling airflow (including duct leakage) may not be adequate – "Weighting Coefficient". Validation of existing Building Energy Simulation methods is recommended

Equipment Sizing (%)

WP (Base)	WP (Measure)	WO32 (NPart)	WO32 (Part)	SubcTF (Base)	SubcTF (Measure)
20%	0%	13%	10%	13.9%	0%

Base Case

- Program (pilot) data – total of 32 projects
- Equipment sizing based on Manual J and Manual S
- Manual S accounts for 115% of total cooling load per Manual J
- Manual S – equipment sizing meets latent and sensible loads at design conditions used in Manual J
- WO32 included Manual J, but excluded Manual S
- WO32 compares Manual J to installed capacity

Measure Case

- Equipment sizing follows Manual J and Manual S requirements

General Notes
System Sizing (%)

- Manual S engineering is used to determine the operating capacity and Sensible Heat Ratio (SHR) of an installed system at local conditions

- The Original Equipment Manufacturers (OEM) engineering performance data was not readily available for the existing equipment (PRE), the Manual S capacities were modeled using custom software (by Roltay) to approximate the OEM data.

- Software created by Roltay Inc. Energy Services is similar in computation function as the DOE/ORNL Heat Pump Design Model.

- The QI program requires the use of both ACCA Manual J [*] for calculating cooling loads and ACCA Manual S [**] for estimating equipment sizing based on sensible and latent loads.

Airflow Capacity (cfm/ton)

WP (Base)	WP (Measure)	WO32 (NPart)	WO32 (Part)	SubcTF (Base)	SubcTF (Measure)
350 cfm/ton	400 cfm/ton	**300 cfm/ton**	**338 cfm/ton**	**300 cfm/ton**	**350 cfm/ton (T24)**

Base Case

- WO32
- Consistent with Proctor study

  Existing - Cochella Valley, CA – 310 cfm/ton (Proctor et al. 1995)

Measure Case

- T24 - “it is mandatory that central forced air systems produce fan watt draws less than or equal to 0.580 watts/CFM and flow at least 350 CFM per nominal cooling ton”
- Parameter falls between Proctor study on California replacement – 388 cfm/ton (Proctor and Downey 1998) and WO32 – 338 cfm/ton

General Notes
Airflow Capacity (cfm/ton)

- Nominal cooling tons established by AHRI ratings for each unit.
- Airflow generally measured at the return-air vent
- There are 3 methods allowed in the program for measuring air flow including the following:
  - (1) Flow hood at the return;
  - (2) rotating vane 4” anemometer measured at the return; and
  - (3) Flow plates measured at the furnace entrance or the return.

References

ID	Evaluated Parameter	General Parameters	Supporting Documentation
1	**Flow Performance (kW/cfm)**	Design full-load power of the supply fan per unit of supply airflow - Fan power; System airflow	Program Data; [5]
2	**Flow capacity (cfm/ton)**	System airflow; system delivery capacity; system (ARI) rated capacity	[1] [5]
3	**Duct Leakage**	Duct leakage - fraction of the supply air that is lost from the ductwork, thereby reducing the design supply air at the zones	Program Data; [4]; and [5]
4	**Equipment Sizing**	HVAC equipment capacity	Program Data per [2] and [3]
7	**System Efficiency**	System Efficiency (SEER)	[5]

[1] HVAC Impact Evaluation FINAL Report WO32 HVAC – Volume 1: Report - CPUC, ED - by DNV GL
[2] ACCA - Residential Load Calculation (Manual J)
[3] ACCA - Residential Equipment Selection (Manual S)
[4] PGE – “HVAC Permitting: A Study to Inform IOU HVAC Programs, by DNV-GL”
[5] 2013 RESIDENTIAL COMPLIANCE MANUAL FOR THE 2013 BUILDING ENERGY EFFICIENCY STANDARDS, Title 24

Q&A

Thanks!