

PG&E EUC Certified High Performance HVAC Pilot Equipment and Protocols

The goal of this mentoring program pilot is to increase the efficiency and performance of newly installed residential HVAC systems, and the key to achieving this is to get installing technicians measuring and commissioning their installations, every time. For this to be widely adopted, we need to use acceptably accurate measurement equipment that is owned or readily obtainable, low cost, and paired with efficient and practical testing protocols. The following sections outline the measuring equipment and protocols selected for this program.

Section I: Measuring Equipment

[A] Supply Airflows: Any fan-assisted flow capture hood that compensates for the backpressure placed against the supply grille is acceptable. Energy Conservatory (EC) FlowBlaster® or Retrotec Flow Finder MK2 are examples of acceptable devices.

[B] System Airflows: Acceptable methods for determining total system airflow is by (1) summation of all supply airflow, (2) using an EC TrueFlow® device or (3) performing a plenum-pressure matching system airflow test using a calibrated duct pressurization setup like a EC DuctBlaster® according to these procedures:

<http://energyconservatory.com/wp-content/uploads/2014/12/8-21-13-AH-flow-webinar.pdf>

[C] Exhaust Airflows: Any fan-assisted airflow device, EC Exhaust Fan Flow Meter™ or an Alnor 6200 low-flow balometer is acceptable.

http://www.energyconservatory.com/sites/default/files/documents/flow_box_manual_dg-700.pdf
http://www.tsi.com/uploadedFiles/_Site_Root/Products/Literature/Spec_Sheets/LoFlo%20Balometer%20Capture%20Hoods_Alnor.pdf

[D] Return Airflows: Same equipment as exhaust airflows plus TSI Accubalance 8380 (or equivalent) capture hood for return (only) airflows over 150 CFM.

http://tsi.com/uploadedFiles/_Site_Root/Products/Literature/Spec_Sheets/8715-8380_AccuBalance_US_5001431.pdf

[E] Distribution System Leakage: Acceptable equipment for measuring total system leakage include the EC DuctBlaster® and the Retrotec DucTester.

[F] Air Temperatures: All air temperature measurements will be taken following the specific procedures listed in the testing protocols. Wet bulbs can be calculated from temperature and relative humidity reading devices, with a wet cotton wick, or a sling psychrometer.

Acceptable devices include any type K thermocouple meter with calibration adjustment and listed accuracy within +/- 1°F, provided it is calibrated monthly and displays Fahrenheit temperature to minimum of 0.1 resolution. Example:

<http://www.fieldpiece.com/products/detail/st4-dual-temperature-meter/dual-temperature/>

Data loggers: Any data logging devices that measure temperature with +/- 1°F published accuracy are acceptable. Loggers that record both temperature and relative humidity, with small size that permits installation within direct airflow, and with fast response times and high accuracies, are preferred but not required. Examples include <http://www.onsetcomp.com/products/data-loggers/ux100-011>, <http://www.onsetcomp.com/products/data-loggers/ux100-023>

[G] Power and Energy (Watts, kW, kWh): Acceptable devices include only devices capable of measuring true RMS (root mean square) Watt/kW power and/or energy in Wh/kWh. Portable hand-held devices/meters that have resolutions down to 10 Watts are ideal like this: <http://www.testequipmentdepot.com/extech/pdf/380940.pdf>

Energy data loggers: Any power/energy data-logging device that measures Watt/kW power and/or energy in Wh/kWh is acceptable (like an SiteSage™ circuit monitoring device). Typically the setup would include a Watt node that requires a logging/pulse counting device, current transformers and test lead connections to it like this: http://www.ccontrols.com/w/WattNode_Pulse

Any 120V loads (furnace fan, HRV) can be measured using a Kill A Watt™ (or equivalent) device that measures Watts.

[H] Pressure (Pascals): Any device capable of accurately measuring differential pressure to a minimum resolution of 0.1 Pascals and minimum accuracy of 1% of reading +/- 0.25 Pascals.

Section II: Measurement Protocols

Item 1: Manufacturer Specifications for Minimum Efficiency

System designer and installer must verify using the AHRI certified product directory that the installed equipment meets the minimum listed standards, and enter the SEER, EER, and AFUE or HSPF in the appropriate boxes.

Item 2: System Sizing Limits

System designer and installer will obtain by measurement, plans or other methods, the conditioned square footage information accurate to within 10% of actual. The maximum cooling capacity of the installed system shall be listed in nominal tons, and the maximum heating capacity (input) in Btu/h. The Square Feet (SF) of conditioned floor area is divided by the installed/connected tons of AC to calculate the SF per ton of air conditioner (AC) sizing. The system passes if there is 800 or more SF per ton of AC installed. There is no upper SF limit to sizing, only minimum SF per ton requirements. If there is a gas furnace, the input in Btu/h is divided by the SF to arrive at Btu/h/SF. Anything 18.0 Btu/h/SF or under is acceptable, with no lower limit.

Item 3: Cooling Coil Airflow and Power

For all air Conditioning installations, the system installer will temporarily disable the outdoor unit from operating and will measure the section [B] approved measuring equipment (see prior section) when the circulating air is between 65 and 78F and minimum MERV 8 filters are installed at all return air locations. Under the same conditions, the Watt draw of the air handler (heat pumps) or the Watt draw of the furnace will be measured using an [G] approved device. The installation will be acceptable if the measured airflow divided by the installed/connected tons is 450 CFM / ton or higher. There is no upper limit to the CFM. Additionally, the installation will pass if the measured Watts divided by the measured CFM is 0.25 Watt/CFM or less.

Item 4: Duct Installation and Airtightness

For all ducted distribution system installations, the system installer will measure total leakage at 25 Pascals of pressure within the distribution system with reference to inside the home, using the approved equipment [E]. The system will pass if the measured leakage divided by the nominal system airflow (tons of AC x 400 CFM/ton) is 3.0% or less. An example is a 2 ton system could leak as much as 24 CFM and pass.

Additional requirements for all installations is that the system installer selected only supply outlet locations within rooms that permitted the shortest possible duct runs, installed all ducting fully extended and fully supported by the ceiling joists/truss bottom chords, and made all duct turns using rigid metal parts to ensure the internal duct area wasn't reduced. System installer will answer whether these requirements were met on the form.

Item 5: Sensible Delivered Capacity and Efficiency

For all system installations, the system installer will perform a single delivered sensible capacity test and compare the results to manufacturer data sheets at test condition (ATC). Systems pass if they deliver 85% or more sensible heat into the conditioned living space. For heat pump and AC systems, the installer will also compare the delivered EER to the manufacturer EER (ATC) (capacity divided by rated power ATC). Systems pass if the delivered EER is 85% or more of the manufacturer EER (ATC).

Equipment type and the indoor/outdoor temperatures will decide what operating mode to run the equipment in on test day.

AC or Heat Pump Procedure:

Setup requirements for installer testing:

1. The indoor dry bulb entering the system will be maintained between 70F-78F during the test procedure for heating and cooling tests.
2. The outdoor temperature for cooling tests will be 78F or warmer. For all temperatures between 78-90F, the airflow through the outdoor unit shall be restricted to maintain a liquid line temperature during testing of 95-100F. No restriction is needed at 90F or warmer.

3. The outdoor temperature for heating tests will be 65F or colder.
4. All interior doors will be open during testing.

The installer will operate the system in normal heating or cooling mode with the same conditions and setup as Item (3) except that the outdoor unit will be in normal operating mode. After 15 minutes of operation, the temperature at the center of each return air grille will be recorded using approved equipment **[F]**, then systematically the temperature in each supply grille is taken and recorded as the installer moves efficiently around the home, then the return grille temperatures are recorded once again. Next the installer will measure supply air flows using approved equipment **[A]**, then measure the power **[G]** of the air handler and the outdoor unit and add them together for total system power. If there are multiple return air locations, the return airflow at each will then be measured **[D]** and recorded (single returns do not need to be measured at this time).

Furnace Procedure:

Setup requirements for installer testing:

1. The indoor dry bulb entering the system will be maintained between 65F-80F during the test procedure.
2. The outdoor temperature will be 65F or colder.

The installer will install a power monitor **[G]** on the furnace circuit and record the rated heat output (Btu/h). After 15 minutes of operation, the temperature at the center of each return air grille will be recorded using approved equipment **[F]**, then systematically the temperature in each supply grille is taken and recorded as the installer moves efficiently around the home, then the return grille temperatures are recorded once again. Next the installer will measure supply air flows using approved equipment **[A]** and if there are multiple return air locations, the return airflow at each will then be measured **[D]** and recorded (single returns do not need to be measured at this time).

Item 6: Room Air Delivery

With the system still operating from Item #5 testing (or a minimum of 15 minutes of system operation) with the same home configuration *plus* any exterior doors and windows closed, the installer will now record the temperature using approved equipment **[F]** within each normally occupied (living) spaces at a point within the center of each room and 3' above the floor. Additionally, at one central living space (Living room, Great room) the temperature shall be recorded with the same equipment at two vertically aligned points 1' off the floor and 1' down from the ceiling. The installation passes if the difference between the highest temperature and lowest temperature recorded at all locations does not exceed 3.0 F degrees.

Next the installer will individually close each interior door to any room with a supply or return grille and record the pressure difference across the closed door using approved equipment **[H]**. The installation passes if there are no readings that exceed 5.0 Pascals.

Item 7: Ventilation

The system installer will measure and record all ventilation airflows using approved equipment [A] and [C], and all fan power using approved equipment [G]. *(Note that exhaust fan power measurements are often the most challenging to record due to permanent wiring, and may require locating the circuit at the panel and wiring in a pigtail so that a plug in kW meter can be used as each one is individually operated)*

The system designer will provide an ASHRAE 62.2-2010 calculation for the ventilation requirements, and the installer will record that information on the form. The system installation passes if the “as configured” ventilation rate exceeds the 62.2 minimums while using equal to or less than 0.45 W/CFM if heat recovery type, and equal to or less than 0.20 W/CFM if exhaust only. *Note that for any exhaust fan to count toward the minimum ventilation rate, it must be configured to operate automatically and be clearly marked for the occupants to understand.*