Consortium for Energy Efficiency
Residential HVAC Initiative
Program Description

Published November 17, 1995
(updated January 1, 2010)

INTRODUCTION

According to a 1992 Electric Power Research Institute (EPRI) survey, more than 200 electric utilities offer incentives for the purchase of high-efficiency residential central air conditioners and heat pumps.[1] Each utility sets its own eligibility thresholds, with the result that manufacturers are faced with a confusing array of different efficiency levels which their products must meet. Thus, utilities as a group are sending a confusing message to manufacturers regarding the efficiency levels they would like to see manufacturers produce and stock. As a result, there is a dearth of equipment on the market today with good annual and peak load performance. In addition, the high-efficiency equipment that is produced may not be locally available in some service areas.

In order to reduce this confusion and improve the availability of high-efficiency equipment, the Consortium for Energy Efficiency (CEE) has developed a recommended set of eligibility thresholds for utility programs that can be used by utilities throughout North America. These eligibility thresholds are not exclusive and are not compulsory. Thus, any participating utility, in addition to providing incentives for equipment meeting these specifications, is free to also provide incentives for equipment meeting other eligibility requirements. Incentive levels and other program design features are left to each individual utility.

A second problem many residential air conditioner and heat pump programs face is that cooling and heating performance in the field is different from performance in the laboratory. Research by several utilities has found that the leading cause of these problems is sub-optimal installation, such as improper refrigerant charge, leaky ducts, inadequate airflow through the system, and system oversizing.[2]

To address this problem, the CEE Initiative includes a recommended program component dealing with proper air conditioner and heat pump installation. While a few utility programs have addressed these problems, most utilities do not have the time nor expertise to develop installation components. The recommended CEE installation component builds upon the experience generated by a few utilities and provides a package that other utilities can adopt without large development expenses. Also, by developing a common approach towards installation, utilities may be able to work together on common training programs and printed materials, providing additional administrative cost savings. However, while individual utilities are strongly encouraged to adopt the installation component, adoption of this component is not required in order to participate in the CEE Initiative.

SCOPE

The CEE Initiative covers single-phase, single-package and split system air conditioners and heat pumps up to 65,000 Btu/hour cooling capacity. Another CEE Initiative covers three-phase equipment and equipment over 65,000 Btu cooling capacity.[3] CEE also offers an Initiative for ground source heat

[1] Blevins and Miller, 1993, 1992 Survey of Utility DSM Programs (Palo Alto, CA: Electric Power Research Institute).
[2] See for example Proctor and Pernick, "Getting it Right the Second Time" and Neal and O'Neal, "The Impact of Residential Air Conditioner Charging and Sizing on Peak Electrical Demand." Both are in the Proceedings ACEEE 1992 Summer Study on Energy Efficiency in Buildings, Vol. 2, Residential Technologies (Berkeley, CA: American Council for an Energy-Efficient Economy).
[3] Consortium for Energy Efficiency, 1994, "High Efficiency Commercial Air Conditioning (HECAC) Initiative" (Boston, MA: CEE).

pumps.[4] The CEE ground-source and air-source air conditioner and heat pump programs complement each other. Room air conditioners are included in a separate Initiative as well.[5]

PROGRAM APPROACH

The Initiative consists of two components: an equipment efficiency component and an installation component.

The equipment efficiency component consists of multiple efficiency tiers: two initial tiers based on equipment approximately 15% more efficient than average equipment being sold today, and a series of higher tiers, based on additional efficiency improvements, for which higher incentives are recommended. For the highest tier, little equipment is on the market today. By setting these eligibility thresholds now, utilities provide a clear target for manufacturers to meet as they develop new equipment.

The installation component consists of a set of installation guidelines that systems should meet. It is recommended that utilities factor in the costs and benefits of meeting these guidelines when they develop programs.

Each of these components is discussed in more detail in the following sections.

HOW TO PARTICIPATE

CEE invites all electric utilities to participate in the CEE Residential HVAC Initiative. For a utility to participate in the CEE Initiative, it must:

1. Provide incentives (rebates or financing) for high efficiency residential air conditioners and heat pumps meeting at least Tier 1 efficiency levels described in the "Equipment Efficiency Component" of this Initiative Description;
   OR
2. Deploy a significant and focused educational/promotional program which identifies and promotes high-efficiency residential air conditioners and heat pumps meeting at least Tier 1 efficiency levels described in the "Equipment Efficiency Component" of this Initiative Description;
   AND
3. Submit a letter of Support to CEE (sample letter is attached at the end of this Initiative Description).

[4] Consortium for Energy Efficiency, 1994, "High Efficiency Residential Geothermal Heat Pump Initiative" (Boston, MA: CEE).
[5] Consortium for Energy Efficiency, 1997, "Super Efficient Home Appliance Initiative" (Boston, MA: CEE).

EQUIPMENT EFFICIENCY COMPONENT

Equipment Rating – Cooling

Presently, air-cooled equipment less than 65,000 Btu/hour is rated in terms of Seasonal Energy Efficiency Ration (SEER). SEER is measured in accordance with a U.S. Department of Energy (DOE) test procedure. SEER ratings are certified by the Air Conditioning, Heating, and Refrigeration Institute (AHRI) and published in directories and databases maintained by AHRI. SEER is a measure of the average efficiency of a unit throughout the cooling season, giving appropriate weight to performance at different operating conditions. As the SEER of a unit increases, generally the annual kWh consumed by the unit will go down by a related amount. However, SEER is not a measure of performance under peak (very hot) conditions. For a given SEER, units on the market may differ in peak load performance by up to 20%.[6]

Peak load performance is frequently measured by the Energy Efficiency Ration (EER), which is measured at an outdoor temperature of 95º F, in accordance with AHRI test procedure AHRI 210/240. In the past, some manufacturers published EER data on their units less than 65,000 Btu/hour, but many did not. EER values are not certified by AHRI. The California Energy Commission (CEC) maintains a publicly available database with EER information.[7] The main limitation of this database is that it includes only the most common system combinations. Beginning in approximately January 1996, AHRI will list EER on its database on the Internet, at which point EER on most models will be publicly available.[8]

Some utilities are interested in only the peak load performance of residential air conditioners and heat pumps. Others are interested only in annual energy use. Many utilities are concerned with both peak and annual performance. The CEE efficiency thresholds are based on both SEER and EER ratings. To be eligible for the CEE Initiative, an air conditioner or heat pump must have both SEER and EER ratings established. Ratings can be established though listing in either the AHRI or the CEC databases.

Equipment Rating – Heating

Presently, air-source heat pumps less than 65,000 Btu/hour are rated in terms of Heating Season Performance Factor (HSPF). HSPF is measured in accordance with a DOE test procedure. HSPF ratings are certified by AHRI and published in directories and databases maintained by AHRI. HSPF is a measure of the average efficiency of a unit throughout the heating season, and is analogous to the SEER measure of cooling performance. As the HSPF of a unit increases, the annual kWh consumed by the unit will go down by a related amount. However, HSPF is not a measure of performance under peak (very cold) conditions. For a given HSPF, units on the market differ in peak load performance by up to 20%.[9]

Peak load performance is frequently measured by the Coefficient of Performance (COP). COP is typically measured at 17º F and 47º F, in accordance with AHRI test procedure AHRI 210/240. The 17º F condition represents peak conditions in many southern states, but falls short of peak conditions in most northern states. Furthermore, the test at 17º F is only for the heat pump and does not reflect if and how much electric resistance heat is used. The 47º F test does not provide information that is especially useful in determining peak load performance. Some manufacturers publish COP data on their units less than 65,000 Btu/hour, but many do not. COP values are not certified by AHRI, nor are they included in AHRI directories; however, they are included in AHRI databases. In addition, the California Energy

[6] Stickney and Shepard, 1994, "Do Air Conditioning Rebates Miss the Mark?" (Boulder, CO: E-Source).
[7] The California Energy Commission's BBS may be accessed via modem by calling 916-654-4069.
[8] AHRI's home page is www.ahrinet.org.
[9] California Energy Commission, 1994, "Directory of Certified Central Air Conditioners an Heat Pumps." March 18, (Sacramento, CA: CEC).

Commission (CEC) maintains a publicly available database with COP information for those manufacturers willing to provide COP data.
Some utilities are interested only in the peak load performance of residential heat pumps. Others are interested in only the annual energy use. Many utilities are concerned with both peak and annual performance. However, given limitations with the present COP ratings, they are not especially useful for determining peak performance. Accordingly, for the present time CEE heating efficiency thresholds will be based on HSPF rating only. As discussed below, the Subcommittee hopes to work With AHRI on improvements to the COP ratings to make them more useful to utilities.

Equipment Rating – Water Heating
AHRI has recently issued a draft Standard 290 to measure combined space and water heating efficiency. Once this procedure is finalized and test data on specific units becomes available, an additional Initiative eligibility credit will be developed for units with good water heating performance.

Additional Equipment Rating Issues
Utilities in hot, dry climates have found the EER at 95º F to be an inadequate reflection of peak performance in their service territories and are therefore interested in EER data at higher temperatures for evaluation purposes. EPRI is currently conducting research on EER at non-standard conditions and the CEC is considering compiling manufacturer data on high-temperature EERs. The Subcommittee will work to ensure that these data are compared and the results shared with interested parties. In addition, the Subcommittee hopes to work with AHRI to determine a method for estimating data on performance at 105º or 115º F without overly burdening manufacturers.

Most eastern utilities are interested in an air conditioner's ability to dehumidify under hot, humid conditions. Dehumidification capability of air conditioners and heat pumps is measured by sensible heat ratio, that is, the percent of sensible (wet bulb) versus latent (dry bulb) cooling capacity under standard rating conditions. The Subcommittee will continue discussions with AHRI to see if this data can be put into the AHRI database on an uncertified basis.

In addition to the efficiency metrics discussed above, the CEE Subcommittee plans to monitor and participate in deliberations on new and modified test procedures. Specifically, the Subcommittee will monitor new equipment developments and new test procedures that are designed to capture efficiency gains not measured by present test procedures. Also, the Subcommittee hopes to work with AHRI and other organizations to develop and publish information on unit power quality (i.e., power factor and harmonics), sensible heat ration at non-standard conditions (i.e., 75º F dry bulb and 63º F wet bulb), and heating efficiency at winter peak conditions (incorporating heat pump performance at low temperatures , e.g., 5º F, as well as the proportion of load this is provided by electric resistance backup coils).

Efficiency Thresholds
The CEE Initiative includes high-efficiency equipment specifications for central air conditioners and air source heat pumps. The current tiers, effective January 1, 2009, are listed in the tables below:

Split Central Air Conditioners

Level	SEER	EER
CEE Tier 1 and ENERGY STAR	14.5	12
CEE Tier 2	15	12.5
CEE Tier 3 (Advanced)	16 or higher	13 or higher

Packaged Central Air Conditioners

Level	SEER	EER
CEE Tier 1 and ENERGY STAR	14	11
CEE Tier 2	14 or higher	12 or higher

Split Air Source Heat Pumps

Level	SEER	EER	HSPF
ENERGY STAR	14.5	12	8.2
CEE Tier 1	14.5	12	8.5
CEE Tier 2	15 or higher	12.5 or higher	8.5 or higher

Packaged Air Source Heat Pumps

Level	SEER	EER	HSPF
CEE Tier 1 and ENERGY STAR	14	11	8
CEE Tier 2	14 or higher	12 or higher	8 or higher

In order for a utility to be considered to be participating in the CEE Initiative, it must adopt Tier 1 or higher tiers. Individual participating utilities are encouraged to adopt as many program tiers as appropriate, and may elect to have additional tiers beyond those in the CEE Initiative. Also, each utility can decide whether their program applies to central air conditioners, heat pumps, or both types of equipment.

A step-function eligibility level arrangement, similar to the one presented above, is presently used by some utilities in their residential air conditioning and heat pump incentive programs. Other utilities use a sliding scale, in which each tenth of a SEER point results in a higher incentive. A step function is recommended in the CEE Initiative because such an arrangement is easier to present and understand than an arrangement with ten times the number of rebate levels and because a sliding scale involving two or more efficiency metrics would be even more complicated. While manufacturers have expressed that they prefer a sliding scale arrangement, the Subcommittee has found that utilities, distributors, and contractors have expressed a preference for a simple tiered approach.

Time Frame

Participating utilities are urged to adopt the Tier 1, 2, and Advanced specifications in their programs. Utilities adopting the CEE Initiative are encouraged to give manufacturers and distributors a minimum of six months notice before beginning their program when possible. Manufacturers have stated that they prefer a year's notice, while distributors and contractors have responded positively to individual utility programs when given three months notice.

If manufacturers are to switch manufacturing to emphasize the higher efficiency levels set by the specifications, and if they are to develop new models that are significantly more efficient than those available today, they seek some confidence that these models will be promoted by utility programs for several years.

Current Availability of Equipment

An analysis of model availability in 2009 indicated that 43,733 air conditioner models, about 27 percent of available models, and 15,042 heat pump models, representing 14% of available models, could meet Tier 1 levels. 32720 air conditioners and heat pumps reached Tier 2 levels, and 4,372 air conditioner model combinations, or three percent of available models, could meet the Advanced Tier requirements.

INCENTIVES

Customer, Dealer, or Manufacturer Incentives

Utilities offering incentives must decide to whom they wish to offer them. There are many advantages and drawbacks of paying incentives to customers vs. dealers vs. manufacturers. Opinions vary as to the best mechanism for reducing equipment cost to help ensure that products reach customers at a price comparable to standard equipment. For example, manufacturers prefer customer incentives. Each utility will decide how best to distribute the incentives.

Incentive Levels

Utilities offering incentives will individually set incentive levels. It is recommended that utilities give higher incentives for higher tiers. It is also recommended that utilities factor in the costs and benefits of meeting the installation guidelines when they set incentive levels. Additionally, utilities are encouraged to give incentives for higher SEERs at given EER levels to reward multiple capacity units; the amount of these additional incentives will also be left to individual utilities. A recommended sample incentive structure is as follows:

Recommended Incentive Structure

Tier	Air Conditioner Incentive	Heat Pump Incentive
1	$A	$A+M
2	$B	$B+N
3	$C	$C+O
4	$D	$D+P
Advanced	$E+	$E+Q+

Additional Incentives:

If SEER rating is 2.0 or more points greater than the minimum SEER for a Tier where EER and HSPF levels are met, it is recommended that additional incentives be provided as follows:

Points above minimum SEER	Incentive
2.0-2.9	$X
3.0-3.9	$Y
4.0+	$Z

Note: Incentives are commonly expressed in $/ton of capacity:

- $A-E will generally be based on value of air conditioning capacity and energy savings and/or incremental cost of each SEER level of improvement.
- $M-Q will generally be based on value of heat pump heating season capacity and energy savings.
- $X-Z will generally be based on value of additional energy savings from high SEER and high HSPF which typically accompanies high SEER) and/or incremental cost of improved SEER.

EDUCATIONAL/PROMOTIONAL PROGRAMS

Utilities that wish to offer an educational/promotional program under the Initiative should develop an understanding of the current market barriers that exist for high efficiency residential air conditioning and heat pump equipment within their region and demonstrate how their programs will address the major market barriers. After their educational/promotional programs have been in place for a period of time, participating utilities should also evaluate the impact of their programs on the local residential air conditioning market (e.g., Are more customers purchasing high-efficiency equipment? Are more dealers stocking high-efficiency equipment?).

LIST OF ELIGIBLE EQUIPMENT

As a service to participating utilities, CEE has developed a listing of eligible equipment meeting the different tiers, available at www.ceedirectory.org.

INSTALLATION COMPONENT

The installation component is a voluntary part of the CEE Initiative; that is, utilities may participate in the Initiative without adopting the installation component or may modify this component to suit their purposes. Alternately, utilities may choose to adopt certain portions of the installation component, or may address installation issues through a separate program. However, CEE urges utilities to consider adoption of this component in order to have consistent programs across utility boundaries and to encourage proper equipment installation in the field. Numerous studies have shown that improper sizing, installation, and controls can greatly reduce the operating efficiency of a system. Correcting these problems can reduce air conditioner and heat pump energy use by 10% on average, with savings as high as 30% in problem homes.[10] Therefore it is important to have an installation component in order to ensure savings; even the highest efficiency equipment which is installed improperly will not produce the desired savings.

The elements of this installation component are excerpted from the ANSI/ACCA 5 QI Standard (v2010).

1.0 PURPOSE

This standard details the nationally recognized minimum criteria for the proper installation of HVAC systems in residential and commercial applications.

2.0 SCOPE

This standard applies to HVAC equipment/components being installed in residential and commercial buildings:

2.1 EQUIPMENT TYPES

2.1.1 Unitary air conditioners, air-source/water-source heat pumps, and geothermal heat pumps,

2.1.2 Furnaces (gas-fired, oil-fired, electric, and other)

2.1.3 Boilers (gas-fired, oil-fired, electric, and other).

EXCEPTIONS:
Due to differing design aspects and control/operation situations, built-up systems (i.e., chillers, custom or specialty-built penthouse units, etc.) are not included in this specification. Buildings employing built-up systems are generally designed by architects or professional engineers. Additionally, commercial buildings using built-up equipment are more likely to benefit from increased owner scrutiny via building commissioners, owner agents, etc.

[10] Proctor and Pernick, 1992, and Neal and O'Neal, 1992. See footnote #2.

2.2 EQUIPMENT SYSTEMS / COMPONENTS

2.2.1 Heating Systems / Components – Single Zone and Multizone

a) Heating-only equipment and heat pumps including air-source, water-source, and geothermal heat pumps.
b) Hot-water coil and/or fin-tube radiation, and/or unit heaters, and/or unit ventilators
c) Electric resistance coil and/or fin-tube radiation, and/or gas unit heaters, and/or unit ventilators
d) Hot air heating (fossil fuel or electric furnace, direct-fired and indirect-fired makeup air equipment)
e) Radiant heat equipment

2.2.2 Cooling Systems / Components – Single Zone and Multizone

a) Cooling-only equipment and heat pumps including air-source, water-source, and geothermal heat pumps.
b) Rooftop single zone, rooftop multi-zone (hot-deck/cold-deck)
c) Single-zone unitary (packaged terminal air conditioners/heat pumps, split-coil-ductless)

3.0 DESIGN ASPECTS

This section focuses on the upfront design procedures/tasks[11] undertaken before the equipment is actually installed.

3.1 VENTILATION

The contractor shall ensure that ventilation calculations are performed for every HVAC system installation/replacement.

3.1.1 REQUIREMENTS

The contractor shall ensure:

Building ventilation requirements (outside air, exhaust air and building pressurization) are performed to recognized standards, codes, or requirements.[12]

[11] Informative Note: During the HVAC system design process, duct sizing calculations need to meet subsequent QI requirements:
– §4.1 & §4.2 Airflow & water flow Across Indoor Heat Exchangers
– §5.2 Airflow Balance

[12] Mechanical ventilation connected to the HVAC system shall not allow the entering mixed-air temperature to be outside the temperature and humidity limits of the OEM heating and air conditioning equipment requirements.

3.1.2 ACCEPTABLE PROCEDURES

The contractor shall follow an appropriate methodology to perform building ventilation calculations.

3.1.3 ACCEPTABLE DOCUMENTATION

The contractor shall include documentation in the installation file indicating that the ventilation calculations were addressed.[13]

3.2 BUILDING HEAT GAIN / LOSS LOAD CALCULATIONS

The contractor shall ensure that heat loss and heat gain load calculations are performed for every HVAC system installation/replacement.

3.2.1 REQUIREMENTS

The contractor shall ensure:

a) For NEW CONSTRUCTION, or when adding new ducts to an existing structure, room-by-room heat gain/loss load calculations are completed

or

b) For EXISTING CONSTRUCTION, without contractor modification of the existing duct system, block load heat gain/loss load calculations are completed.

NOTE 1. EXISTING BUILDING EXCEPTION:
Building heat gain / loss load calculations are not required if the original load calculations are on hand and accurately reflect the building's current construction and use.

NOTE 2. LOAD CALCULATIONS:
Room-by-room load calculations may be undertaken if so chosen by the contractor.

3.2.2 ACCEPTABLE PROCEDURES

The contractor shall perform one of the following acceptable procedures for fulfilling the desired criteria:

a) Follow an appropriate methodology/procedure to perform building load calculations (e.g., ACCA Manual J®, ACCA Manual N®, ASHRAE Handbook Guidelines, DOE EnergyPlus™, or other approved equivalents per the authority having jurisdiction)

[13] The ventilation load is to be included in the overall heat gain/loss load calculations (§3.2)

or

b) Confirm that the calculations were performed by a qualified third party.

3.2.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Load calculation worksheets included in the installation file

or

b) Appropriate documentation in the installation file.

3.3 PROPER EQUIPMENT CAPACITY SELECTION

The contractor shall ensure that all equipment is properly sized and selected prior to being installed.

3.3.1 REQUIREMENTS

The contractor shall ensure:

a) For CENTRAL AIR CONDITIONERS and HEAT PUMPS - the selected equipment will satisfy the building's load requirements at design conditions

i. OEM product data demonstrates that latent requirements are addressed,[14]

and

ii. Total equipment capacity is between:

- 95% and 115% of total cooling requirements (for air conditioners and heat pumps)

or

- 95% and 125% of total cooling requirements (for heat pumps with heating dominated requirements)

or

- the next largest nominal piece of equipment, per OEM increment,[15] that is available for either to satisfy the latent and sensible requirements.

[14] It is acceptable to include supplemental dehumidification equipment with the HVAC system to meet excess latent loads.

[15] For *Residential Applications*: Single-speed systems generally have nominal size increments of ½ ton. Multi-speed or multi-stage equipment may have nominal size increments of one ton. For *Commercial Applications*: The nominal size increases can be 1 – 5 tons.

b) For gas-fired or oil-fired WARM AIR SYSTEMS and HEATING BOILERS - the heating capacity of the selected equipment will satisfy the heating requirement at design conditions

i. WARM AIR SYSTEMS - output capacity between 100% and 140% of calculated system load unless dictated by the cooling equipment selection

ii. HEATING BOILERS - equipment capacity between 100% and 115% of calculated system load, OR the next largest nominal piece of equipment that is available

3.3.2 ACCEPTABLE PROCEDURES

Using OEM performance information and industry-approved procedures (e.g., ACCA Manual S® for residential applications, ACCA Manual CS® for commercial applications, OEM guidelines, OEM equipment selection programs, or other approved equivalent per the authority having jurisdiction), the contractor is to confirm that the selected equipment satisfies/meets the load requirements at the system design conditions.

3.3.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Equipment performance information in the installation file

and

b) Written job documentation or checklist in installation file

3.4 GEOTHERMAL HEAT PUMP GROUND HEAT EXCHANGER

The contractor shall observe industry design practices for the proper design of the exterior ground heat exchanger.

3.4.1 REQUIREMENTS

The contractor shall ensure:

Ground heat exchangers are designed to satisfy the HEATING AND COOLING load requirements of the building.

i. The ground interface heat exchanger fluid[16] temperatures [extremes] and flow rates used as the basis for design equipment capacity are within the range specified in OEM guidelines
and

ii. The ground heat exchange design methodology incorporates:
- building loads and total installed equipment capacity
- ground heat exchanger type, materials, and geometry
- soil thermal characteristics
- climatic characteristics of the project location

3.4.2 ACCEPTABLE PROCEDURES

The contractor shall follow OEM guidance, recognized industry practices (ASHRAE, IGSHPA, NGWA), or procedures approved by the authority having jurisdiction.

3.4.3 ACCEPTABLE DOCUMENTATION

The contractor shall include documentation in the installation file indicating that the ground heat exchanger design objectives were met using OEM, IGSHPA, NGWA ASHRAE, or procedures approved by authority having jurisdiction.

3.5 MATCHED SYSTEMS

The contractor shall ensure that all heating and cooling equipment are properly matched systems as identified by industry-recognized certification programs.

3.5.1 REQUIREMENTS

The contractor shall ensure:

Matched systems in accordance with one of the following:

a) AHRI Product Certification directory/database (www.ahridirectory.org)

or

b) CEE directory of AHRI-verified equipment (www.ceehvacdirectory.org)

or

c) Selection of indoor coil and air handler to correctly match OEM performance data for matching indoor and outdoor components that meet §3.3 and §3.4 requirements.

[16] Fluids may be water-or antifreeze solution for closed loop ground heat exchangers - or refrigerants in DX based ground heat exchangers. Verify fluid is allowed by local ground water authority or administrative authority.

3.5.2 ACCEPTABLE PROCEDURES

The contractor shall use one of the following acceptable procedures for fulfilling the desired criteria:

a) Confirmation of system matching compliance as compared to a recognized product certification database

or

b) Confirmation of the matched system operational performance data to OEM documentation for all equipment being installed (i.e., air handling unit, indoor coil, outdoor condensing unit)

3.5.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Copy of the AHRI *or* CEE-AHRI record/certificate, with appropriate reference number indicated for the matched system, in the installation file.

or

b) Copy of OEM-provided catalog data, indicating acceptable combination selection and performance data, in the installation file.

4.0 EQUIPMENT INSTALLATION ASPECTS

This section focuses on the HVAC system installation.

4.1 AIRFLOW THROUGH INDOOR HEAT EXCHANGERS

The contractor shall verify that the airflow through the indoor blower unit, (e.g. furnace, fan coil, air handler) is within acceptable CFM ranges.

4.1.1 REQUIREMENTS

The contractor shall ensure:

Measured airflow[17] through the indoor heat exchanger (with all accessories and system components in place):

a) For cooling (e.g., refrigerant, water) and heat pump applications

[17] When verifying design airflow at design fan speed, there is little distinction between a split capacitor fan motor (PSC) or a variable speed fan motor (e.g., brushless DC, electronically commutated motor; ECM). See "Airflow" in Appendix B. Note: ECM fan motors are designed to modify their RPMs in order to provide a prescribed (programmed) air volume in response to static pressure conditions (actually torque on the output shaft). Hence, an ECM may use more or less power than a comparable PSC motor in the same application.

i. Airflow through the unit, at fan design airflow under steady state condition is within 15% of the airflow required per the system design,

and

ii. Airflow through the unit is within the CFM range listed in the OEM product data,[18]

and

iii. Measured external static pressure (ESP)[19] is:

1) Within OEM-specified acceptable range,

and

2) Not more than 25% or 0.10 iwc (which ever is greater) over the calculated ESP used to design the duct system. [Exception for existing buildings: measured ESP is not required for change-out applications if there has been no modification to the pre-existing ductwork.]

b) For gas-fired, oil-fired, or electric heat exchanger applications

i. Airflow, through the heat exchanger, at the selected fan speed under steady-state conditions is within 15% of the airflow required per the system design,

and

ii. Airflow through the indoor heat exchanger is within the CFM range listed in the OEM product data,

and

iii. Heat exchanger airflow requirements shall be considered separately from any combined and attached cooling coils sharing the same distribution duct system,

and

iv. Measured external static pressure (ESP) is:

1) Within OEM-specified acceptable range,

and

2) Not more than 25% or 0.10 iwc (which ever is greater) over the calculated ESP used to design the duct system. [Exception for existing buildings: measured ESP is not required for change-out applications if there has been no modification to the pre-existing ductwork.]

[18] Airflow across the coil is typically between 350 to 450 CFM per ton. Adjustments may be needed between dry and wet coils.

[19] Static pressure measurements require clean components: filters, coils, and fans for each indoor unit type

4.1.2 ACCEPTABLE PROCEDURES

The contractor shall use one of the following acceptable methods for fulfilling the design criteria:

a) OEM CFM/static pressure drop coil table method using a manometer and probe to determine the static pressure drop across a cooling coil, furnace, or fan coil unit and compare with OEM values

or

b) Traversing using a manometer and probe, or an anemometer (e.g., hot wire, rotary style) or other methods per ACCA, AABC, ASHRAE, ASTM, NEBB, SMACNA, or TABB procedures

or

c) Flow grid measurement method

or

d) Pressure matching method[20]

or

e) The temperature rise method (for heating only: gas or oil furnace, electric resistance heat, geothermal and water source heat pump) to verify proper airflow through the heat exchanger or heater elements. [NOTE: It is not acceptable to use the temperature rise method to determine cooling airflow over the indoor coil.]

4.1.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data and calculations recorded on start-up sheet

or

b) Documented field data and calculations recorded on service records

and

c) Written job documentation or checklist in the installation file

4.2 WATER FLOW THROUGH INDOOR HEAT EXCHANGERS

The contractor shall verify that the water flow[21] through the refrigerant-to-water, water-to-water, or water-to-air heat exchanger are within acceptable ranges.

[20] Use of a calibrated fan to match the supply plenum pressure and measurement of the system airflow through the active fan. Note: Methods for use with brushless DC or ECM blowers in accordance with the motor or OEM instructions.

[21] Water may be treated or contain antifreeze.

4.2.1 REQUIREMENTS

The contractor shall ensure:

a) Water flow through the heat exchanger is within 10% of the water flow required per the system design.
and
b) Water flow through the heat exchanger is within the range listed in the OEM product data.

4.2.2 ACCEPTABLE PROCEDURES

The contractor shall test using one of the following acceptable methods for fulfilling the desired criteria:

a) The water pressure drop method
or
b) The water temperature change method
or
c) Any method approved and specifically stated by the OEM that can be used to determine the water flow rate

4.2.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data and calculations recorded on start-up sheet
or
b) Documented field data and calculations recorded on service records
and
c) Written job documentation or checklist in the installation file

4.3 REFRIGERANT CHARGE

The contractor shall ensure that the HVAC system has the proper refrigerant charge.

4.3.1 REQUIREMENTS

The contractor shall ensure:

a) For the SUPERHEAT method, system refrigerant charging per OEM data/instructions and within ± 5°F of the OEM-specified superheat value.

or
b) For SUBCOOLING method, system refrigerant charging per OEM data/instructions and within ± 3°F of the OEM-specified subcooling value

or
c) Any method approved and specifically stated by the OEM that will ensure proper refrigerant charging of the system

NOTE 1. FLOW THROUGH THE HEAT EXCHANGER:
Proper airflows §4.1 and/or water flows §4.2 through the heat exchanger must be within acceptable OEM tolerances before the refrigerant charge can be measured and/or adjusted.

NOTE 2. MEASUREMENT PARAMETERS:
The system must be within the OEM's temperature parameters at steady state conditions before system charge measurements are undertaken.

NOTE 3. REFRIGERANT CHARGE TOLERANCES:
Refrigerant charge tolerances noted (i.e., ± 5°F and/or ± 3°F of the OEM-recommended optimal refrigerant charge) are not additive to any OEM-specified tolerances.

4.3.2 ACCEPTABLE PROCEDURES

The contractor shall use one of the following acceptable procedures for completing the desired measurements after confirmation of required airflow (per §4.1) and/or water flow (per §4.2) through the indoor coil:

a) Superheat test done under outdoor ambient conditions, as specified by the OEM instructions (typically, 55°F drybulb temperature or higher)

or

b) Subcooling test done under outdoor ambient conditions, as specified by the OEM instructions (typically, 60°F or higher)

or

c) Any method approved and specifically documented by the OEM that will ensure proper refrigerant charging of the system.

NOTE: If outdoor conditions require a follow-up visit to finalize the charging process, this should be recorded at both the initial visit and the follow-up visit.

4.3.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data AND operating conditions recorded on start-up sheet

or

b) Documented field data AND operating conditions recorded on service records

and

c) Written job documentation or checklist in the installation file

4.4 ELECTRICAL REQUIREMENTS

The contractor shall ensure all electrical requirements are met as related to the installed equipment.

4.4.1 REQUIREMENTS

The contractor shall ensure:

a) LINE and LOW VOLTAGES per equipment (single and three-phase) rating plate - the percentage (or amount) below or above nameplate values are within OEM specifications and/or code requirements

and

b) AMPERAGES per equipment (single and three-phase) rating plate - the percentage (or amount) below or above nameplate values are within OEM specifications and/or code requirements

and

c) LINE and LOW-VOLTAGE wiring sizes per NEC (National Electric Code) or equivalent

and

d) GROUNDING/BONDING per NEC or equivalent

4.4.2 ACCEPTABLE PROCEDURES

The contractor shall test using the following acceptable procedures for fulfilling the design criteria:

a) Volt meter to measure the voltage

and

b) Amp meter to measure the amperage

and

c) Verify measurements with nameplate and over current protection criteria

4.4.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documents showing that selections are in compliance with OEM specifications

and

b) Written job documentation or checklist in the installation file

4.5 ON-RATE FOR FUEL-FIRED EQUIPMENT

The contractor shall ensure the equipment combustion is "on-rate", for gas-fired or oil-fired equipment, and is at the equipment nameplate value.

4.5.1 REQUIREMENTS

The contractor shall ensure:

a) Gas-Fired Equipment:

The contractor shall ensure:

i. Firing rate within ± 5% of nameplate input for gas equipment (or per OEM specifications)

and

ii. Temperature rise within the nameplate limits

b) Oil-Fired Equipment:

The contractor shall ensure:

i. Correct nozzle flow rate and spray angle for correct firing rate per nameplate input,

and

ii. Correct oil pump pressure for nozzle installed and at OEM's specified values

and

iii. Temperature rise per nameplate limits

4.5.2 ACCEPTABLE PROCEDURES

a) Gas-Fired Equipment:

The contractor shall test using one of the following acceptable procedures for fulfilling the desired criteria:

i. Clocking the meter or other fuel input measurement per OEM instructions,

and

ii. Measuring the temperature rise at steady state conditions (with airflow first verified by §4.1) – furnaces only.

or

iii. Perform a combustion analysis per OEM installation or gas burner instructions.

b) Oil-Fired Equipment:

The contractor shall fulfill the following criteria:

i. Verify nozzle or alternate input nozzle per OEM installation and oil burner instructions.

and

ii. Verify oil pump pressure with a dial or electronic gauge designed for oil pressure measurement

and

iii. Measure the temperature rise at steady-state conditions (with airflow first verified by §4.1) –furnaces only.

or

iv. Perform a combustion analysis per OEM installation and oil burner instructions.[22]

4.5.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data recorded on start-up sheet

and

b) Written job documentation or checklist in the installation file

4.6 COMBUSTION VENTING SYSTEM

The contractor shall ensure proper sizing, design, material selection and assembly of the combustion gas venting system.

4.6.1 REQUIREMENTS

The contractor shall install the vent system to:

a) CATEGORY I vent system sized per OEM instructions and the National Fuel Gas Code (NFGC, NFPA 54)

or

b) CATEGORY I vent system sized per OEM instructions and the International Fuel Gas Code (IFGC)

or

[22] Combustion analysis is necessary when setting up an oil burner. Additionally, new oil-fired equipment no longer standardizes the pump pressure at 100 psig. Hence, incorrect pump pressure may result in an incorrect input rate for the equipment.

c) CATEGORY II, III and IV vent system sized per OEM instructions

and

d) CATEGORY II, III and IV vent system sized per required local code

4.6.2 ACCEPTABLE PROCEDURES

The contractor shall use one of the following acceptable procedures for fulfilling the installation criteria:

a) Comparison of the actual installation to appropriate fuel gas venting tables for Category I vent systems

or

b) Comparison of the actual installation to appropriate OEM instructions, and local codes for Category II, III and IV vent systems

4.6.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data recorded on start-up sheet

or

b) Documented field data recorded on service records

and

c) Written job documentation or checklist in the installation file

4.7 SYSTEM CONTROLS

The contractor shall ensure proper selection and functioning of system operational and safety controls.

4.7.1 REQUIREMENTS

The contractor shall ensure:

a) Operating controls and safety controls are compatible with the system type and application, and the selected controls are consistent with OEM recommendations and industry practices

and

b) Operating controls and safety controls lead to proper sequencing of equipment functions, with all controls and safeties functioning per OEM or customer design specifications

NOTE OPERATING CONTROLS:
Examples of operating controls include: thermostats, humidistats, economizer controls, etc. Examples of safety controls include: temperature limit switch, airflow switch, condensate overflow switch, furnace limit switch, boiler limit switch, etc.

4.7.2 ACCEPTABLE PROCEDURES

The contractor shall use the following acceptable procedures for fulfilling the desired design criteria:

a) Confirmation of the control/safety selections made

and

b) Supporting OEM literature related to the selections made

and

c) Verification of correct cycling/operational sequences of controls and safety devices/systems per system design and OEM specifications

4.7.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documents showing that controls/safeties selections are in compliance with OEM specifications

and

b) Written job documentation or checklist in the installation file indicating that controls/safeties function properly

5.0 DISTRIBUTION ASPECTS

This section focuses on heating and cooling delivery elements of the installed HVAC system.

5.1 DUCT LEAKAGE

The contractor shall ensure the ducts are sealed and that air leakage (CFM) is minimized.

5.1.1 REQUIREMENTS

The contractor shall ensure:

a) For NEW CONSTRUCTION, test using any one of the three options:

   i. Ducts located inside the thermal envelope have no more than 10% total duct leakage (airflow in CFM: duct pressure 25 Pascals),

   or

   ii. Ducts located outside the thermal envelope have no more than 6% total duct leakage (airflow in CFM: duct pressure 25 Pascals),

   or

   iii. Per local code or authority having jurisdiction

b) For EXISTING CONSTRUCTION, test using any one of the three options:

   i. No more than 20% total duct leakage (airflow in CFM: duct pressure 25 Pascals)

   or

   ii. 50% improvement on existing leakage rate or until 5.1.1.b.i. is achieved

   or

   iii. Per local code or authority having jurisdiction

NOTE 1. DUCT LEAKAGE:
The total duct leakage allowable pertains to the percentage of CFM leakage as compared to the overall air handling fan flow (see §4.1) operating at design conditions. The airflow leakage allowable shall be based on the higher of the winter heating airflow or of the summer cooling airflow.
TOTAL duct leakage = SUPPLY duct leakage + RETURN duct leakage.

NOTE 2. DUCT SEALING:
For duct sealing, all duct sealing materials shall be rated to UL 181A or UL 181B specifications and shall be used in strict accordance with OEM instructions.

5.1.2 ACCEPTABLE PROCEDURES

The contractor shall test using one of the following acceptable procedures for fulfilling the desired criteria:

a) Duct pressurization tests[23] at 25 Pascal

or

b) FOR COMMERCIAL BUILDINGS, airflow comparison method[24]

[23] Duct leakage is measured using a duct pressurization test through a calibrated fan or orifice. Duct registers are sealed, a fan is attached to one opening, the ducts are pressurized, and the amount of air flowing through the fan is quantified. A commonly known system is Duct Blaster®; there are several others as well.

or

c) Hybrid blower door/airflow measuring device subtraction[25]

or

d) Duct pressurization test at referenced pressure standard by authority having jurisdiction.

5.1.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data recorded on start up sheet

or

b) Documented field data recorded on service records

and

c) Written job documentation or checklist in the installation file

5.2 AIRFLOW BALANCE

The contractor shall ensure room airflows meet the design/application requirements.

5.2.1. REQUIREMENTS

The contractor shall ensure:

a) For NEW CONSTRUCTION or addition of new ducts to an existing structure (with interior doors closed AND open) –

For Residential Buildings: The individual room airflows are within the greater of ± 20%, or 25 CFM of the design/application requirements for the supply and return ducts.
For Commercial Buildings: The individual room airflows are within the greater of ± 10%, or 25 CFM of the design/application requirements for the supply and return ducts.

or

b) For EXISTING CONSTRUCTION without contractor modification of existing ductwork: No additional ACCA QI requirements apply.

or

---

[24] Total room supply CFMs and return CFMs compared with blower capability (e.g., airflow measuring device method: Commonly referred to as Flow Hood™, Shortridge or Balometer™, Alnor), as per procedures specified by ACCA, AABC, ASHRAE, NEBB and TABB.

[25] A calibrated fan measures whole-building positive or negative pressure on the building, then duct leakage is measured by placing an airflow capture hood over the grilles and registers.

c) For NEW OR EXISTING CONSTRUCTION the airflow balance is per local code or authority having jurisdiction.

NOTE ON AIRFLOW THROUGH INDOOR HEAT EXCHANGERS:
Per §4.1, airflow through the heat exchanger must be within the OEM's specified range for all furnace, fan coil, and air handler applications.

5.2.2 ACCEPTABLE PROCEDURES

The contractor shall test using one of the following acceptable devices for fulfilling the desired criteria:

a) Airflow measuring device (AMD)[26] used per specifications from the AMD manufacturer

or

b) Duct traverse with Pitot tube and manometer per procedures specified by ACCA, AABC, ASHRAE, NEBB, SMACNA or TABB

or

c) Measure the average airflow using an anemometer (hotwire or rotary) per specifications from the test equipment manufacturer.[27]

5.2.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Documented field data recorded on start up sheet or test and balance form

or

b) Documented field data recorded on service records

and

c) Written job documentation or checklist in the installation file

5.3 HYDRONIC BALANCE

The contractor shall ensure water flows meet the design/application requirements.

[26] Commonly referred to as Shortridge flow hood™ or Alnor Balometer™.

[27] The use of anemometers is acceptable if (1) grille "free areas" are known and if (2) the measurement tolerances for the instrument/device being used are considerable tighter than the airflow balance tolerances. The grill "free area" is commonly known as the area-K (or Ak) and the values are provided by the grille/diffuser OEM.

5.3.1. REQUIREMENTS

The contractor shall ensure:

a) For NEW CONSTRUCTION, or addition of new piping to an existing HVAC system, the water flow to individual room or zone heat exchangers are within ± 10% of the design/application GPM requirements.

or

b) For EXISTING CONSTRUCTION without contractor modification of existing piping: No additional ACCA QI requirements apply.

or

c) For NEW OR EXISTING CONSTRUCTION the room/zone hydronic balance is per local code or authority having jurisdiction.

NOTE ON WATER FLOW THROUGH HEAT EXCHANGER:
Per §4.2, water flow through the heat exchanger must be within the OEM's specified range for all boilers, and water-to-water geothermal heat pump applications.

5.3.2 ACCEPTABLE PROCEDURES

The contractor shall use one of the following acceptable tests for fulfilling the desired criteria:

a) Manometer and probe used per instructions from the instrument manufacturer.

or

b) Ultrasonic/Doppler flow meter used per instructions from the instrument manufacturer.

or

c) Pressure gauge used per instructions from the instrument manufacturer

or

d) Procedures specified by OEM

5.3.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) A copy of documented field data recorded on start up sheet or test and balance form

or

b) Documented field data recorded on service records

and

c) Written job documentation or checklist in the installation file

6.0 SYSTEM DOCUMENTATION AND OWNER EDUCATION ASPECTS

This section focuses on providing owners with job documentation, operation instructions, and education to assist them in properly operating and maintaining their systems.

6.1 PROPER SYSTEM DOCUMENTATION TO THE OWNER

The contractor shall provide records pertaining to the HVAC system installation as well as the operation and maintenance to be performed.

6.1.1 REQUIREMENTS

The contractor shall ensure:

a) An installation file of required and relevant information is created and provided to the homeowner or the building owner/operator (or designated agent).

   i) Required documentation: Information detailed in the *Acceptable Documentation*[28] of each applicable section.

   and

   ii) Relevant documentation: additional information applicable to the HVAC activity undertaken.[29]

and

b) Copies of documents from §6.1.1.a and a record of the model and serial numbers of all equipment installed are maintained at the contractor's place of business.

6.1.2 ACCEPTABLE PROCEDURES

The contractor shall confirm that all the listed requirements are met.

---

[28] Examples of required acceptable documentation include: ventilation calculations (§3.1), load calculations (§3.2), OEM performance data (§3.3), AHRI certificates (§3.5), records of measurements (§4.1, §4.2, §4.3, §4.4, §4.5), documented field data (§4.6), written documentation of proper operation sequences (§4.7), duct leakage tests (§5.1), test and balance reports (§5.2, §5.3), and customer education (§6.2).

[29] Examples of relevant documentation include: permits, as-built drawings (including the type, size, and location of all underground heat geothermal heat exchange piping), survey data, equipment submittals, maintenance and operating instructions, and equipment/contractor warranties.

6.1.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Written job documentation or checklist in the installation file

and

b) Signed documentation from the customer that the listed requirements were offered/met

6.2 OWNER/OPERATOR EDUCATION

The contractor shall inform the customer on how to both operate and maintain the installed equipment and will promote system maintenance to aid in the continuing performance of the installed equipment.

6.2.1 REQUIREMENTS

The contractor shall ensure:

a) Customers are instructed on system operation of installed equipment

and

b) Customers are instructed on the maintenance requirements for the installed equipment

and

c) Customers are instructed on warranty procedures and responsibilities

and

d) Customers are provided with contact information for warranty, maintenance, and service requirements

6.2.2 ACCEPTABLE PROCEDURES

The contractor shall confirm that all the listed requirements are met.

6.2.3 ACCEPTABLE DOCUMENTATION

The contractor shall provide evidence of the following:

a) Written job documentation or checklist in the installation file

or

b) Signed documentation from the customer that the listed requirements were offered/met; including the date and names of the trainer and the building owner/operator (or designated agent) receiving the instruction.

INITIATIVE ADMINISTRATION

Services Provided by CEE

CEE is widely disseminating the Initiative Description and undertaking other recruiting efforts to encourage other utilities to participate in the Initiative. Utilities interested in the Initiative need not join CEE, although they are encouraged to do so. The CEE Residential HVAC Subcommittee is assisting in recruiting efforts for the Initiative.

CEE will compile information about participating utilities' programs that it will present to manufactures and other participating utilities. Working with other organizations, CEE will also identify information about equipment meeting the CEE eligibility thresholds that will be made available to participating utilities in a database directory. CEE will not (i) convey any information from or about a manufacturer to another manufacturer (ii) communicate any non-public information from or about any utility or manufacturer. CEE hopes to provide these services using funds from its existing budget. Should additional services be requested by the Subcommittee and agreed upon by CEE, supplemental funding may be requested form participating utilities.

Utility Endorsement

Each interested utility is asked to inform CEE of its intent to adopt the CEE equipment and/or installation components. A suggested sample letter, which is not intended to be legally binding, is attached to this Initiative Description. Individual utilities may modify this letter to suit their purposes; however, care should be taken to include all of the requested information when modifying the letter.

For More Information

Questions about the Initiative should be directed to:

John Taylor
Program Manager
CEE
98 N. Washington St., Suite 101
Boston, MA 02114
(617) 532-0944
jtaylor@cee1.org