



June 14, 2007

MEMO

To: California Energy Commission Codes & Standards Staff
From: Cynthia Austin & Jon McHugh, HMG
on behalf of the PG&E Codes and Standards Program
Re: **Remove EER loophole from ACM**

This memorandum provides a summary of market research and analysis completed on the Energy Efficiency Ratio (EER) values found for single phase, air-cooled air conditioners with cooling capacity less than 65,000 Btu/hour and a Seasonal Energy Efficiency Ratio (SEER) value of 13. EER is a "ratio calculated by dividing the cooling capacity in Btu/h by the power input in Watts at any given set of rating conditions, expressed in Btu/h/W"¹. The EER is a steady state value tested at 95°F ambient air temperature. The SEER rating is the result of three tests at 82°F ambient air temperature and includes the effect of cycling. The rating is standardized by the Air-conditioning and Refrigeration Institute (ARI). The research was completed on behalf of PG&E for their comments to the California Energy Commission on the appropriate EER base case value for the Nonresidential Alternative Calculation Method (ACM) Approval Manual. The current EER base case value for a SEER 13 air conditioner in the ACM Manual is 10.

Methodology and Analysis

The following data sources were used for the analysis:

- The ARI's Unitary Directory of Certified Product Performance for Air Conditioners and Air Conditioner Coils Single Package and Split Systems²: A listing of products that have underwent ARI certification process for product performance
- The California Energy Commission's Appliance Database³: A listing of all appliances currently certified to the California Energy Commission by their manufacturers as meeting currently-applicable efficiency standards.

¹ ARI, 1984. ARI Standard 210/240-84, unitary air-conditioning and air-source heat pump equipment. Air-Conditioning and Refrigeration Institute.

² Air-Conditioning and Refrigeration Institute. "Unitary Directory of Certified Product Performance for Air Conditioners and Air Conditioner Coils Single Package and Split Systems." (2006). <<http://www.aridirectory.org/ari/ac.php>>. (Accessed 07 June, 2007)

³ California Energy Commission. "Appliance Database." (June 7, 2007). <<http://www.energy.ca.gov/appliances/appliance/>>. (Accessed 07 June, 2007)

For Figure 1, both data sources were analyzed to determine the number of SEER 13 products listed in each source, the average EER found for all products, the minimum EER found for all products, and the maximum EER found for all products. It should be noted that for the CEC Appliance Database, the minimum EER is 10.5.

| | Number of Products | Average EER | Minimum EER | Maximum EER |
|------------------------|--------------------|-------------|-------------|-------------|
| ARI Product Directory | 33,534 | 11.1 | 6.8 | 13.0 |
| CEC Appliance Database | 721 | 11.5 | 10.5 | 12.7 |

Figure 1. EER Product Information for SEER 13 Air Conditioners

Error! Reference source not found. lists the number of products found between six EER value categories and the percentage of each category compared to the total number of products. For products with EER values under 10, the percentage of units falling under that category was minimal at less than 0.4%. For products with EER values under 10.6, the percentage of units falling under that category was less than 4% of the total products. About 90% of the products were found to have EER values between 11 and 13. The CEC and ARI databases may not agree about the exact distribution of EER's for SEER 13 equipment but they both agree there is very few models with and EER less than 11.0.

| EER Bin | CEC Count | CEC % of Total | CEC % Cumulative | ARI Count | ARI % of Total | ARI % Cumulative |
|--------------|-----------|----------------|------------------|-----------|----------------|------------------|
| Less than 10 | 0 | 0.0% | 0.0% | 148 | 0.4% | 0.4% |
| 10.0 to 10.5 | 14 | 1.9% | 1.9% | 1,141 | 3.4% | 3.8% |
| 10.6 to 10.9 | 62 | 8.6% | 10.5% | 1,997 | 6.0% | 9.8% |
| 11.0 to 11.3 | 283 | 39.3% | 49.8% | 22,516 | 67.1% | 76.9% |
| 11.4 to 11.6 | 88 | 12.2% | 62.0% | 4,178 | 12.5% | 89.4% |
| 11.7 to 11.9 | 74 | 10.3% | 72.3% | 2,587 | 7.7% | 97.1% |
| 12.0 to 12.9 | 200 | 27.7% | 100.0% | 964 | 2.9% | 99.99% |
| 13 and more | 0 | 0.0% | 100.0% | 3 | 0.01% | 100.0% |
| Total | 721 | 100% | | 33,534 | 100% | |

Figure 2. EER Bin Data for SEER 13 Air Conditioners in CEC Appliance Database and the ARI Certified Product Performance database

Conclusion

The current calculation methodology which gives credit for unit with EER values over 10 is undesirable. It gives at least 10% air conditioning credit for typical air conditioning performance. Over 95% of the models listed in both the CEC and ARI database are above EER 10.5. Over 90% of the units have EER's greater than 10.9 in both the CEC and ARI databases. Giving credit for units that perform well under hot conditions is desirable in the warmer climate zones (2, 4, 9-15). From the data, it appears that credit should be given when the EER exceeds something in excess of 11 either 11.0 or 11.3. From this data it is clear that the EER base value of 10 is a giveaway of approximately 10% compliance credit on over 90% of the product models.

In addition we recommend that EER credit should only be given to those systems that have been tested for their performance. For most third party indoor coils, the efficiency of the system is based on a simulation model and not on test data. For less complex systems (windows) the National Fenestration Rating Council (NFRC) requires a test to validate a family of windows that are then allowed to be simulated for minor deviations in design, we think the same should be true for air conditioners.

Proposed NACM Language

NACM Section 2.5.2.7 Equipment Performance of Air Conditioners with SEER Ratings and Heat Pumps with SEER and HSPF Ratings

(Original language)

Standard Design: The standard design shall use performance curves based on the SEER of the equipment required by the Standards. The default EER, as defined below shall be used. The standard design heat pump shall have an HSPF as required by section 111. The COP at 47° F shall be determined as below. The efficiency at other outdoor temperatures shall be based on the default DOE-2 HEAT-EIR-FT curve....

The EER for different EWB and ODB conditions. These are given by the following equations.

$$\text{Equation N2-1} \qquad \qquad \qquad \text{EER}_{67,82} = \text{SEER}$$

$$\begin{aligned} \text{Equation N2-2} \qquad \qquad \qquad \text{EER}_{67,95} &= \text{From Manufacturers Data} \quad [\text{when available}] \\ &= 10 - (11.5 - \text{SEER}) \times 0.83 \quad [\text{default for SEER} < 11.5] \\ &= 10 \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad [\text{default for SEER} \geq 11.5] \end{aligned}$$

Proposed change (Continue default slope to SEER 13):

$$\begin{aligned} \text{Equation N2-3} \qquad \qquad \qquad \text{EER}_{67,95} &= \text{From Manufacturers Data} \quad [\text{when available}] \\ &= 10 - (11.5 - \text{SEER}) \times 0.83 \quad [\text{default for SEER} < 13] \\ &= 11.245 \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad \qquad [\text{default for SEER} \geq 13] \end{aligned}$$

Alternate proposal (modify slope to SEER 13, EER 11):

$$\begin{aligned} EER_{67,95} &= \text{From Manufacturers Data} \quad [\text{when available}] \\ \text{Equation N2-4} \quad &= 8.755 + (SEER - 10) \times 0.74833 \quad [\text{default for SEER} < 13] \\ &= 11.0 \quad [\text{default for SEER} \geq 13] \end{aligned}$$

Proposed RACM Language

RACM Section 3.6.4 Cooling Equipment

Original language

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Standard Design. The cooling system for the *Standard Design* building with a central system shall be of the same type identified in the Appliance Efficiency Regulations and selected for the proposed design with a SEER meeting the Appliance Efficiency Regulations minimum requirements. For non-ducted non-central cooling equipment, the efficiencies shall be from the Appliance Efficiency Regulations for Room Air Conditioners, Room Air Conditioning Heat Pumps, Package Terminal Air Conditioners and Package Terminal Heat Pumps for the type and size in the *Proposed Design* where the size may be a user input or shall default to 24 Btu per hour per square foot of conditioned floor area. When a *Proposed Design* uses both a split system air conditioner and another type of air conditioner, the *Standard Design* SEER shall be a conditioned floor area weighted average of the SEERs of the cooling equipment.

Proposed Language

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Standard Design. The cooling system for the *Standard Design* building with a central system shall be of the same type identified in the Appliance Efficiency Regulations and selected for the proposed design with a SEER meeting the Appliance Efficiency Regulations minimum requirements. For non-ducted non-central cooling equipment, the efficiencies shall be from the Appliance Efficiency Regulations for Room Air Conditioners, Room Air Conditioning Heat Pumps, Package Terminal Air Conditioners and Package Terminal Heat Pumps for the type and size in the *Proposed Design* where the size may be a user input or shall default to 24 Btu per hour per square foot of conditioned floor area. When a *Proposed Design* uses both a split system air conditioner and another type of air conditioner, the *Standard Design* SEER shall be a conditioned floor area weighted average of the SEERs of the cooling equipment. [The EER used for calculating the energy consumption of a SEER rated standard central air conditioner shall be the lesser of the EER rating of the air conditioner used in the proposed design or the default EER calculated from the SEER value in Equation R4-41.](#)

RACM Section 4.7.1 Cooling System Energy

Original language

Equation R4-41

When

$$\text{SEER} < 11.5 \quad \text{EER} = 10 - (11.5 - \text{SEER}) \times 0.83$$

$$\text{SEER} \geq 11.5 \quad \text{EER} = 10$$

Proposed change (Continue default slope to SEER 13):

Equation R4-41

When

$$\text{SEER} < 13 \quad \text{EER} = 10 - (11.5 - \text{SEER}) \times 0.83$$

$$\text{SEER} \geq 13 \quad \text{EER} = 11.245$$

Alternate proposal (modify slope to SEER 13, EER 11):

Equation R4-41

When

$$\text{SEER} < 13 \quad \text{EER} = 8.755 + (\text{SEER} - 10) \times 0.74833$$

$$\text{SEER} \geq 13 \quad \text{EER} = 11.0$$

Statewide Savings

Statewide savings is approximately 10% for all air conditioning loads for all new performance method applications obtaining the EER credit. However the difference between EER 11 and EER's over 11.5 still provides a 5% cooling credit that is an incentive to purchase units that are in the .top 20% of EERs.

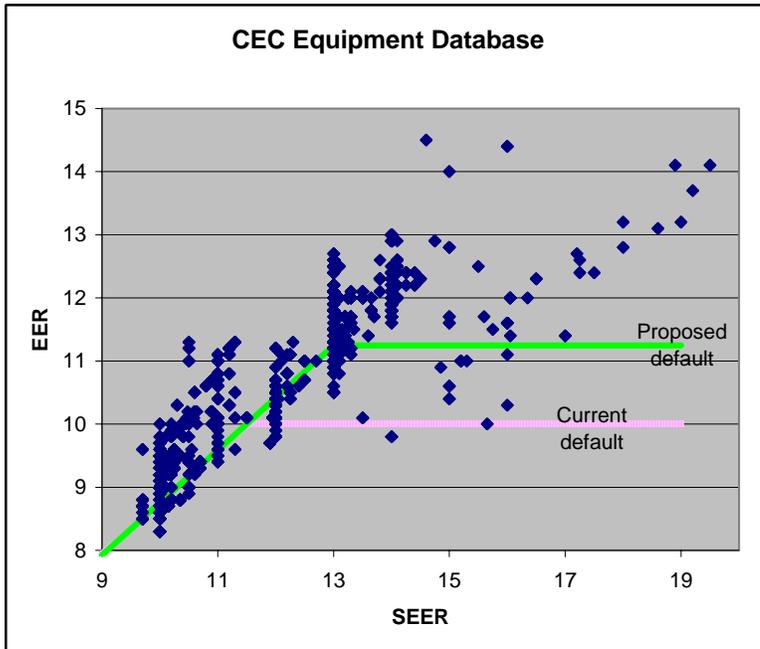


Figure 3: Proposal and Current Default plotted on CEC database

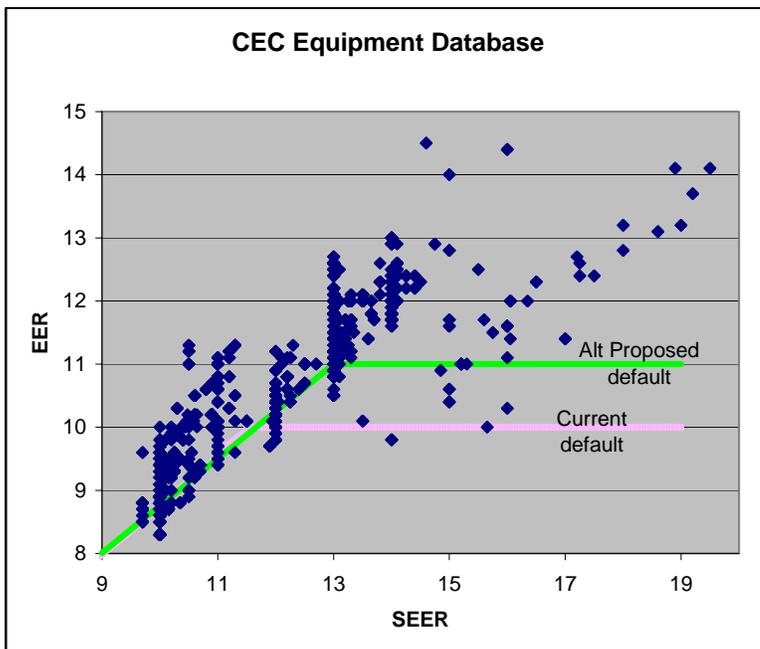


Figure 4: Alternate Proposal and Current Default plotted on CEC database

