2008 DEER Update - Summary of Measure Energy Analysis Revisions
August 2008
(Version 2008.2.01 – 06-07 Draft Ex Ante Update version)

Table of Contents

Tables

Figures

Changes to DEER 2008 methods and assumptions for the version 2008.2.xx (06-07 ex ante update version) compared to version 2008.1,02 (09-11 planning version) are highlighted within this document using the blue font color as this sentence.

I. GENERAL REVISIONS – ALL BUILDINGS

The most fundamental revision from the 2005 DEER is the reclassification of many residential and non-residential building measures from “non-weather sensitive” to “weather sensitive”. Previously, for many measures, impacts were determined using very simplified engineering calculations that provided only a net annual estimate of impacts in electricity kWh, electricity kW and natural gas therms. Impacts are now determined via a full year energy analysis using the DOE-2.2 building energy modeling software. This approach has the following benefits:

- Energy use impacts are now distributed throughout an entire year (8760 hours) so that time of use impacts can be calculated including a demand reduction which utilizes the CPUC adopted DEER methodology and load shapes which can be extracted and applied to the CPUC adopted hourly avoided costs for energy efficiency;
- Interactive affects with heating and cooling systems are now included in the impacts.

Impacts for the following groups of measures are now calculated using whole-building energy simulation (i.e are weather sensitive):

- Interior Lighting (for residential and nonresidential building types)
- Refrigerator/Freezer replacements (for residential building types)
- Refrigerator/Freezer recycling (for residential building types)

The secondary peak period was revised to better capture a more appropriate three day heat wave within the 16 CEC Title 24 climate zones. The primary and secondary peak periods are found in Table 1 and Table 2 below. The DEER team recommends utilizing the updated peak period definitions when reporting demand savings. Demand values based on both peak period definitions are included in the DEER2008 database.

	Start Date					12p - 6p
CZ	Month	Day	Weekday	Peak T	Ave T	Ave T
CZ01	Sep	30	Mon	80	58	65
CZ02	Jul	22	Mon	99	78	93
CZ03	Jul	17	Wed	89	65	79
CZ04	Jul	17	Wed	97	71	87
CZ05	Sep	3	Tue	93	68	80
CZ06	Sep	24	Tue	89	67	72
CZ07	Sep	9	Mon	92	70	78
CZ08	Sep	23	Mon	98	78	89
CZ09	Sep	23	Mon	102	78	91
CZ10	Aug	12	Mon	104	83	98
CZ11	Aug	21	Wed	101	78	97
CZ12	Jul	22	Mon	103	77	96
CZ13	Jul	30	Tue	106	85	100
CZ14	Jul	15	Mon	104	86	101
CZ15	Sep	9	Mon	111	94	107
CZ16	Aug	26	Mon	91	69	86

Table 1: Primary Peak Demand Period

	Start Date					12p - 6p
CZ	Month	Day	Weekday	Peak T	Ave T	Ave T
CZ01	Sep	30	Mon	80	58	65
CZ02	Jul	22	Mon	99	78	93
CZ03	Jul	17	Wed	89	65	79
CZ04	Jul	17	Wed	97	71	87
CZ05	Sep	3	Tue	93	68	80
CZ06	**Jul**	**9**	**Tue**	**85**	**69**	**77**
CZ07	Sep	9	Mon	92	70	78
CZ08	Sep	23	Mon	98	78	89
CZ09	**Aug**	**6**	**Tue**	**101**	**78**	**92**
CZ10	**Jul**	**8**	**Mon**	**104**	**83**	**99**
CZ11	**Jul**	**31**	**Wed**	**104**	**81**	**98**
CZ12	**Aug**	**5**	**Mon**	**103**	**81**	**100**
CZ13	**Aug**	**14**	**Wed**	**106**	**87**	**102**
CZ14	**Jul**	**9**	**Tue**	**106**	**90**	**103**
CZ15	**Jul**	**30**	**Tue**	**114**	**96**	**108**
CZ16	**Aug**	**6**	**Tue**	**96**	**73**	**89**

Bold values are changhes from the primary peak period.

Table 2: Secondary Peak Demand Period

II. GENERAL REVISIONS – RESIDENTIAL BUILDINGS

A. Calibration

Previously, for the 2005 and 2001 DEER projects, the calibration of residential DEER results utilized a “usage factor” multiplier on the annual heating and cooling simulation results. The simulations used a single “typical” heating and cooling thermostat schedule for each climate zone. The usage factor accounted for the fraction of homes that were not using their heating and/or cooling system at any given time and aligned the annual energy use with target values derived from the Residential Appliance Saturation Study[1] (RASS). A single usage factor was used for all cooling results; two heating usage factors were used, as a function of climate zone. Overall results agreed between target and simulated results, but results for particular climate zones and vintages could be off by a large fraction. The expansion of the DEER MAS tool to include internal load measures (i.e. interactive effects) and the reporting of hourly electricity impact values precludes using this simplified calibration approach.

A more detailed approach to the calibration process was developed:

- A library of thermostat schedules was developed based on the RASS data. Earlier research regarding thermostat setpoints (from RASS) was utilized to describe the predominant heating and cooling thermostat schedules used in residential dwellings.
- Each residential simulation (including both base and measure cases) is repeated for five different heating and cooling schedules. Both the annual and hourly results from these simulations are weighted together to arrive at the typical energy use for a particular climate zone, building vintage, residence type and measure definition.
- The thermostat schedules used for a particular climate zone and building vintage (and their associated weights) are adjusted so that the weighted annual total heating and cooling energy align with the target values.

[1] California Energy Commission, “Residential Appliance Saturation Study”, publication #400-04-09, June 2004

An example of the thermostat specifications and weights is given in Table 3 below.

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints				Cooling Temperature Setpoints				Tstat Weight
			Morning	Day	Evening	Night	Morning	Day	Evening	Night	
CZ10	Before 1978	T1	60	60	60	60	83	80	80	83	0.10
		T2	65	68	68	65	76	83	83	76	0.10
		T3	65	65	65	65	80	83	83	80	0.30
		T4	65	70	70	65	85	85	85	85	0.20
		T5	68	68	68	68	90	90	90	90	0.30
	1978 - 1992	T1	68	65	65	68	83	80	80	83	0.20
		T2	65	68	68	65	80	80	80	80	0.15
		T3	72	72	72	72	76	83	83	76	0.15
		T4	70	65	65	70	85	85	85	85	0.30
		T5	68	68	68	68	90	90	90	90	0.20
	1993 - 2001	T1	68	65	65	68	83	76	76	83	0.10
		T2	70	70	70	70	83	80	80	83	0.10
		T3	68	68	68	68	80	80	80	80	0.30
		T4	70	65	65	70	76	83	83	76	0.30
		T5	65	65	65	65	85	85	85	85	0.20
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.10
		T2	68	68	68	68	83	76	76	83	0.20
		T3	70	65	65	70	78	78	78	78	0.35
		T4	70	70	70	70	83	80	80	83	0.20
		T5	68	65	65	68	80	80	80	80	0.15
	After 2005	T1	68	68	68	68	74	74	74	74	0.30
		T2	70	65	65	70	83	76	76	83	0.40
		T3	70	70	70	70	78	78	78	78	0.20
		T4	68	65	65	68	83	80	80	83	0.05
		T5	72	72	72	72	80	80	80	80	0.05

Table 3: Example of Heating/Cooling Thermostat Specifications for Single-Family Building[2]

Calibration Results

Figure 1, Figure 2, Figure 3, and Figure 4 below, show the results of the single-family calibration effort for the 2005 and the updated 2008 DEER projects. The simulated and target values for the 2008 effort typically differ by less than 5% across all vintages and climate zones. A couple of exceptions are cooling in climate zone 14 and heating in climate zones 15 and 16. In these cases the thermostat setting and weights are set to get the closest match possible; the main limitation in these cases is that the specified weights affect both the cooling and heating energy use, so it is not possible to change the weighted heating value without changing the weighted cooling value as well.

RAS does not include annual energy use values for manufactured housing or mobile homes. Therefore, the thermostat schedules used for single family analysis were also used for the manufactured home measure analysis.

[2] For complete listing see "DEER2008 Residential Calibration Tables.xls" which is attached as Appendix 1.

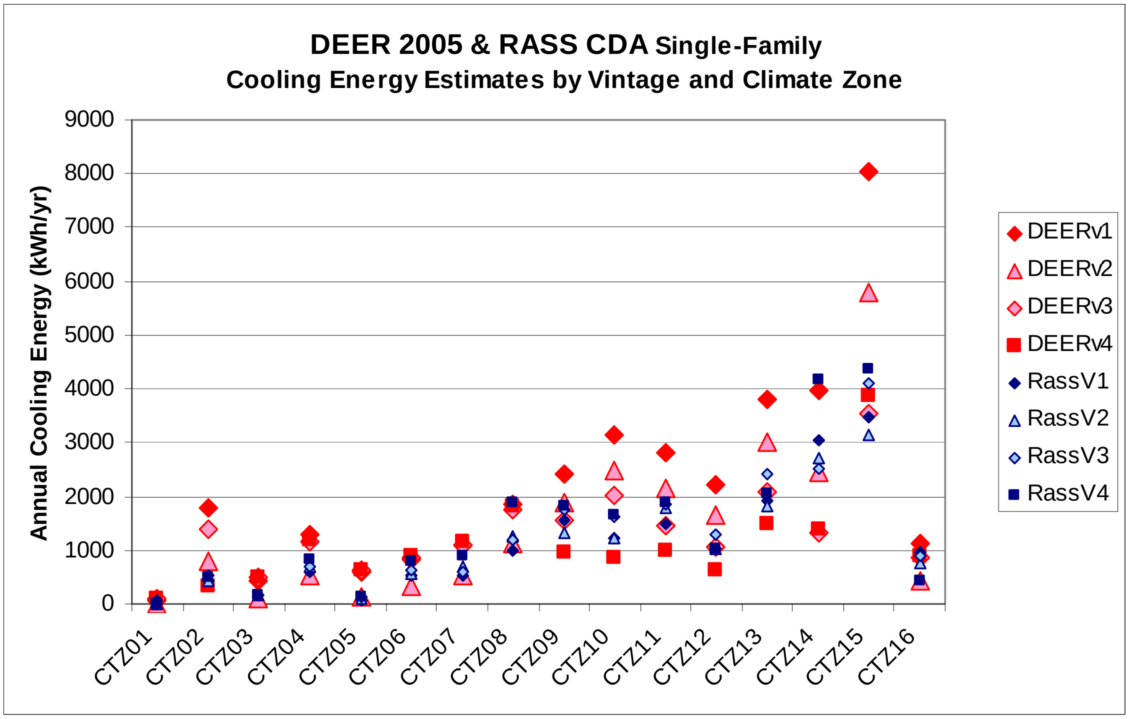

Figure 1: DEER2005 Cooling Calibration for Single Family

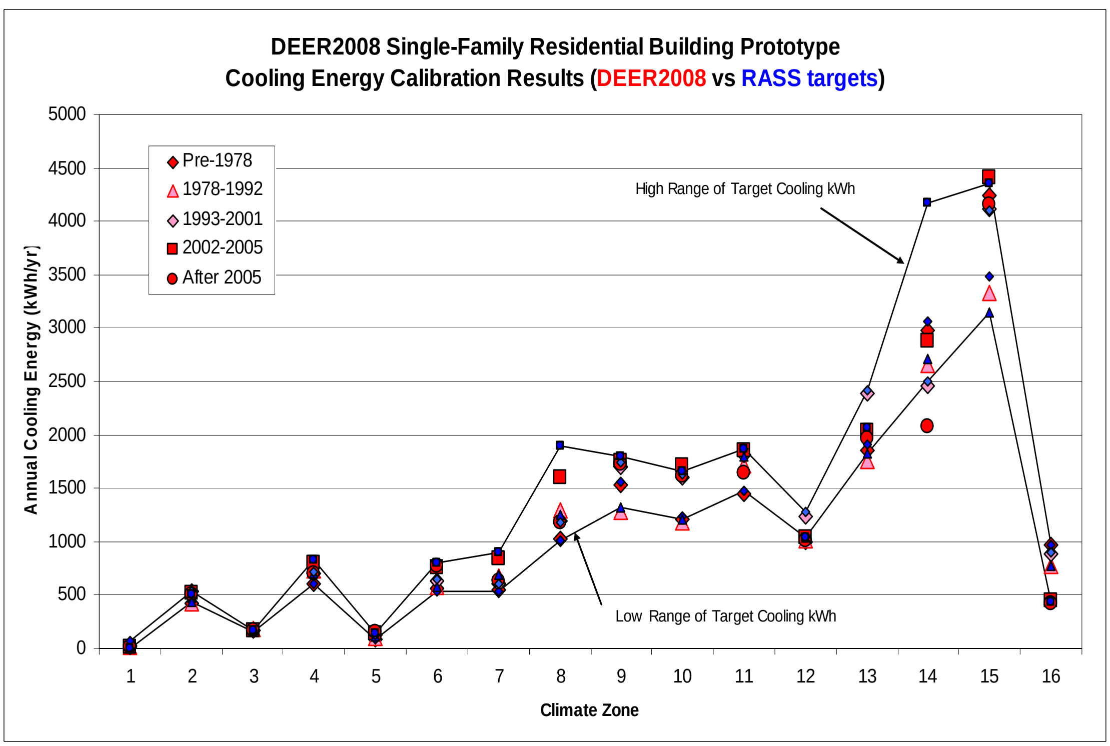

Figure 2: DEER2008 Cooling Calibration for Single Family

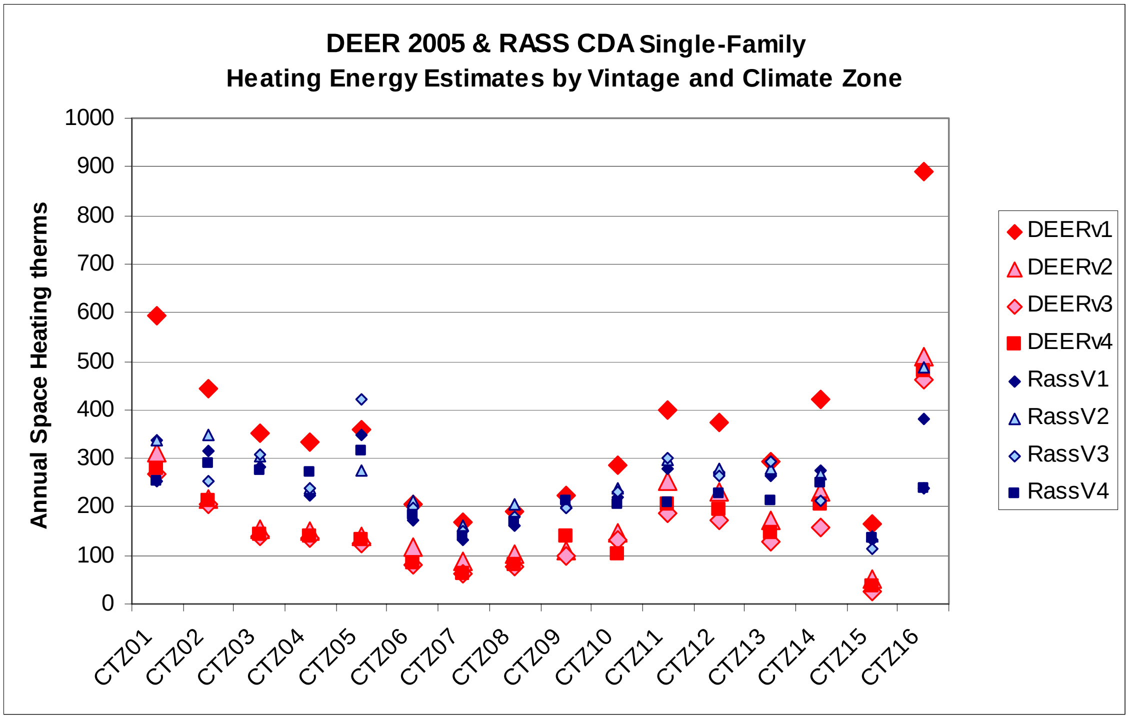

Figure 3: DEER2005 Heating Calibration for Single Family

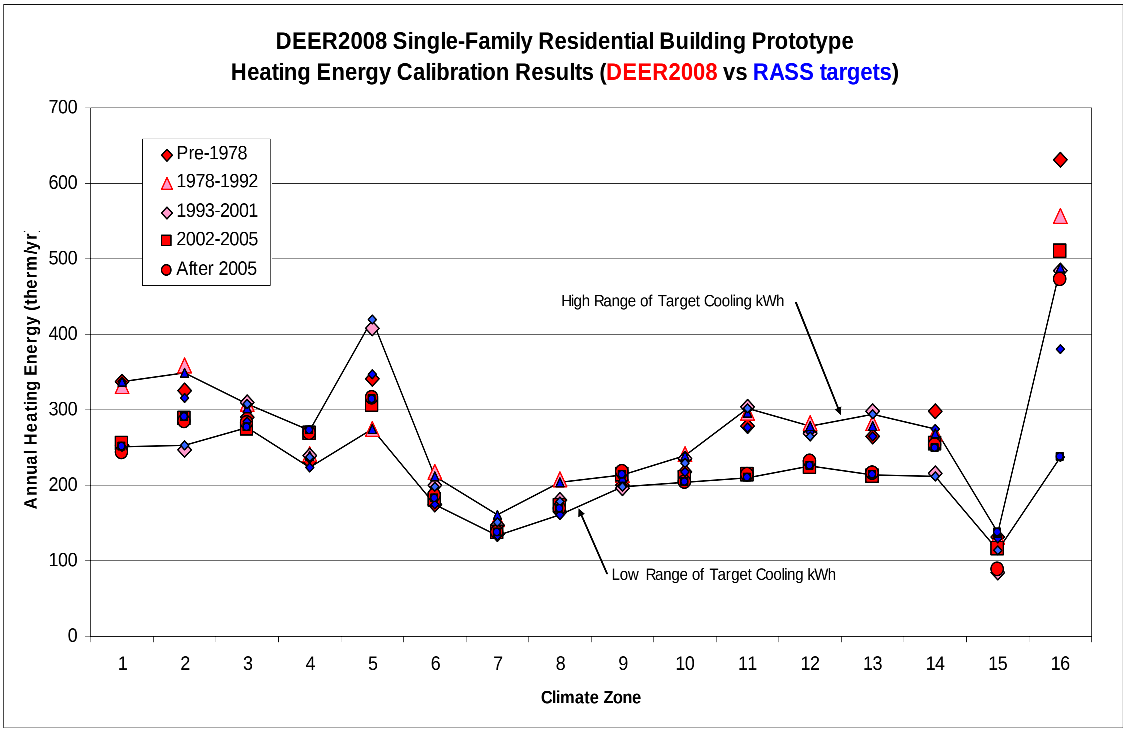

Figure 4: DEER2008 Heating Calibration for Single Family

B. Baseline Energy Performance Characteristics

Some characteristics of the oldest (pre-1978, 1978-1992) and newest (after 2005) single family prototypes have been revised. Changes to the older building vintages reflect improvements to these buildings since they were built and replacement of HVAC systems over the past 30 years.

1. *Pre-1978:* In 2005, the oldest vintage's energy efficiency characteristics were so poor that the energy use was more than twice that of other vintages. The following characteristics of the oldest vintage have been revised:
    a. Wall and roof insulation average R-values increased to about half of current Title 24 requirements
    b. Glazing U-Factor decreased from 1.23 (typical for single glazing) to either 0.90 or 0.95 depending on climate zone.
    c. Cooling SEER increased from 8.5 to 10.0.
    d. Heating AFUE increased from 70% to 78%.
2. *1978-1992:* The following characteristics have been revised:
    a. Wall and roof insulation average R-value increased to about two-thirds of current Title 24 requirements.
    b. Glazing U-Factor decreased from 1.23 (typical for single glazing) to either 0.90 or 0.95 depending on climate zone.
    c. Cooling SEER increased from 8.5 to 10.0.
    d. Heating AFUE increased from 70% to 78%.
3. *After 2005:* The following envelope characteristics have been revised to meet current Title 24 requirements:
    a. Fenestration U-Factor and SHGC revised.
    b. All duct insulation levels increased.

Internal loads, composed of various residential appliances and lighting, are no longer specified as a single "lumped sum" gain, but are disaggregated into all of the individual categories that may be impacted by an energy saving measure. The National Renewable Energy Laboratory's "Building America Research Benchmark Definition" was utilized to define the end-use characteristics. California-specific performance characteristics are used were applicable.

Lighting is specified as an annual total direct energy use by the following equation:

$$\text{Lighting kWh/yr} = 0.8 \times \text{BuildingArea} + 455$$

Both gas and electric appliances are specified based on the building area and the number of bedrooms. Table 4 specifies energy use by use of coefficients, where:

$$\text{Annual kWh} = E_0 + E_1 \times \text{NBr} + E_3 \times \text{BuildingArea and}$$
$$\text{Annual therm} = G_0 + G_1 \times \text{NBr} + G_3 \times \text{BuildingArea}$$

and where NBr is the number of bedrooms and BuildingArea is the conditioned floor area of the residence.

	Electricity use					Gas Use				
	Coefficients			Int.Gain Fraction		Coefficients			Int.Gain Fraction	
Appliance	E_0	E_1	E_2	Sensible	Latent	G_0	G_1	G_2	Sensible	Latent
Refrigerator	669	0	0	1.00	0.00					
Clothes Washer(1)	26.9	0	0	1.00	0.00					
Dishwasher(1)	87.8	0	0	0.60	0.15					
Misc Loads	1086	172.5	0.280	0.81	0.02	4.47	0.77	0.0012	0.13	0.25
Clothes Dryer Elec(1)	1227.4	0	0	0.15	0.05					
Cooking Elec	604	0	0	0.40	0.30					
Clothes Dryer Gas(1)	96.9	0	0	1.00	0.00	43.9	0		0.10	0.05
Cooking Gas	0	0	0	0.00	0.00	78	0		0.30	0.20

Notes:

(1) Loads presented are for Single Family only. See discussion below for discussion of calculated clothes washer and dishwasher annual energy use.

Table 4: Residential Appliance Energy Use Coefficients and Internal Gain factors[3]

Typical annual energy use and hot water consumption for clothes washers and dishwashers are calculated using standardized calculation methods[4] based on observed total annual cycles from CLASS[5] for single family, multi-family and manufactured home building types. Annual cycles, energy use and hot water consumption are listed in Table 5

	Clothes Washer						**Dishwasher**		
Building Type	Cycles/ yr	Hot Water Gallons	Machine Energy kWh	Dryer Machine Energy kWh	Dryer Drying Energy kWh	Dryer Drying Energy Therms	Cycles/ yr	Hot Water Gallons	Machine Energy kWh
SFAM	296	1179.0	26.9	96.9	1130.5	43.9	153	1241.0	87.8
MFAM	272	1083.8	24.7	89.0	1038.9	40.3	111	901.6	63.7
DMO	224	892.5	20.4	73.3	855.5	33.2	153	1241.0	87.8

Table 5: Residential Appliance Energy Use by Building Type

[3] *"Building America Research Benchmark Definition, Updated December 20, 2007"*, United States Department of Energy, Building Technologies Program; NREL/TP-550-42662

[4] Annual energy use is calculated using the spreadsheet "baanalysis.xls", which is a supporting calculation tool to the refenrece:

"Building America Research Benchmark Definition, Updated December 20, 2007", United States Department of Energy, Building Technologies Program; NREL/TP-550-42662

The spreadsheet is used to calculate the values contained on the "Energy Guide" labels included with all new appliances. Energy Guide values are calculated based on specified total annual cycles that are different from those observed reported in CLASS. The DEER team recalculated annual energy use for clothes washers and dishwashers using baanalysis.xls, but with annual cycles reported in CLASS.

[5] RLW Analytics, Inc. "2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study", Final Report, prepared for California's Investor Owned Utilities, June 2, 2005.

III. MEASURE REVISIONS – RESIDENTIAL BUILDINGS

A. Interior Lighting

Interior lighting measures consist of compact fluorescent (CFL) replacements of incandescent lamps in various applications, fixture types and wattages. The absolute, per lamp, wattage reduction is calculated with the following formula:

power reduction = 2.53 * cfl rated power

The above 2.53 values was derived from the RLW (2005) study by considering only standard screw based fixtures with spiral type CFLs (which averaged 18.15 watts in that study) and standard incandescent (which averaged 64.14 watts in that study.) These types were chosen as representative of the vast majority of upstream lighting program products and their replaced lamps. This value is slightly lower than a similar value calculated using the KEMA (2005) self report data (18.5 watts for CFL and 68.1 watts for incandescent lamps) for all types and placements within homes. Residential lighting operates 2.18 full load hours per day for a total of 796 annual full load hours. This value is taken from the KEMA (2005) study using only the actual logger data, excluding imputed data and garage lamps (13 of the 586 loggers.)

The DEER energy results are gross savings values for installed lamps; they do not include other factors that must be considered, including leakage of upstream program lamps to outside the IOU service areas, breakage of lamps at any point prior to possible installation, delay of installation due to shipment times or purchaser storage rather than installation. These factors are expected to reduce and or delay installation credit and thus gross savings realization by 25-50% depending upon the types of products, the sales channel, and the packaging of the product (single vs. multi-packs.) Some stored products will be installed later in the cycle delaying installation but not reducing the full cycle realization rate; other stored product will not be installed within the cycle and thus reduce the cycle gross realization rate, however, may be fully or partially installed in the next cycle.

B. Refrigerators/Freezers

Refrigerators and freezers are relatively simple appliances that have rather complex thermodynamic interactions with their environment. Their energy use is both *affected by* and *affects* their environmental space temperature. A refrigerator in a warm space, for example, uses more energy than a similar refrigerator in a cooler space. At the same time, the energy use of the refrigerator ultimately ends up warming the space it is in.

These interactive effects can be quite significant, especially considering that the analysis includes refrigerators and freezers located in both conditioned and unconditioned spaces and in very hot and relatively cool climates. In order to account for these effects, the DEER simulation engine was modified to have the refrigerator/freezer energy use be a function of the temperature of the space it is in. Though the research on this subject is sparse, the relationship between energy use and the environmental temperature is both expected and observed.

A 1991 study[6] shows a relationship between the rated energy use of a refrigerator and actual use under a range of environmental temperatures.

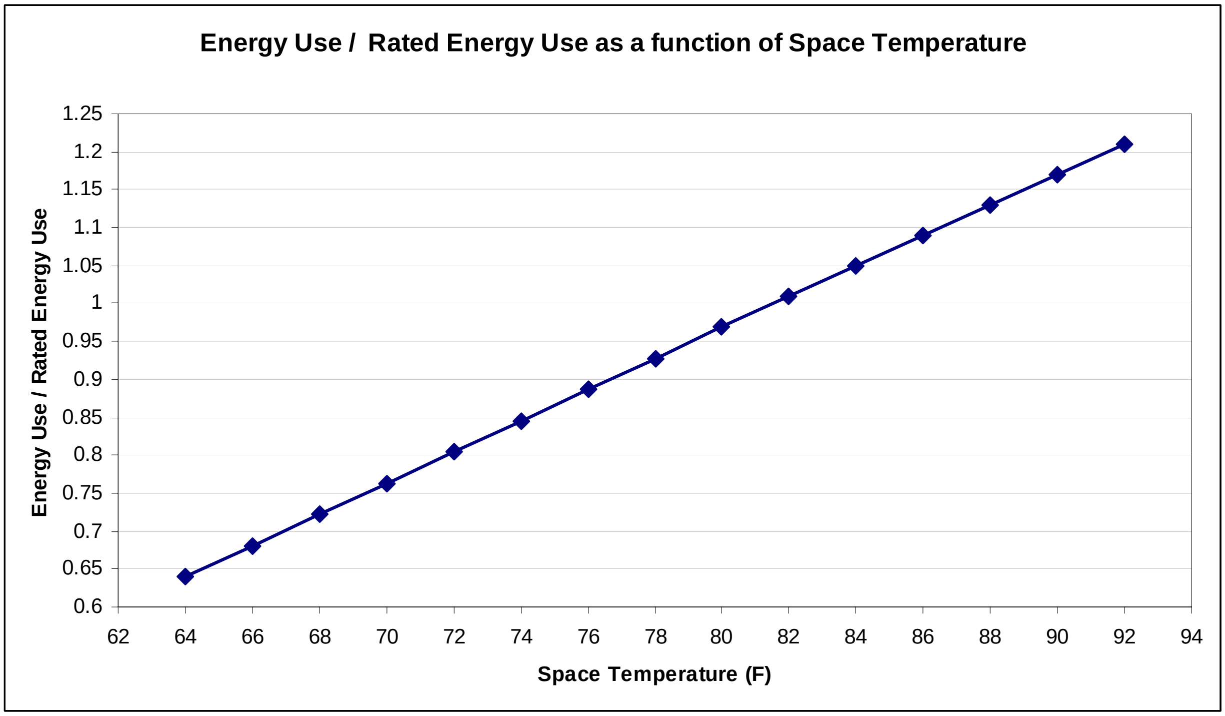

Figure 5: Refrigerator Energy Use as a function of Environmental Temperature

The functional relationship shown in Figure 5 is used for all the refrigerator and freezer simulations conducted for the DEER2008 analyses.

1. Refrigerator/Freezer Replacements – Conditioned Space Only

Refrigerator and freezer measures are divided into several standard DOE covered models. Impacts are determined applying the rated annual UEC across a full year operating schedule. The simulation software also adjusts the energy use of the appliance by the ambient operating temperature since the ambient operating temperature typically varies from the rating temperature. Customer savings are based on improvement between the Customer Average (CA) appliance and the Measure (MS). Above code savings are based on the improvement between the minimum code required efficiency (CS) for the appliance and the MS. Efficiency levels are established as follows:

- CA levels are from RLW 2005[7] - see specific notes to Table 6 below

[6] "PG&E Refrigerator Field Metering Project," Final Report 1991, Proctor Engineering Group. See Home Energy Magazine Online Jan/Feb 1993 at http://www.homeenergy.org/archive/hem.dis.anl.gov/eehem/93/930114.html

- CS from CEC appliance database
- MS is 15% better than CS

Replacements of refrigerators and freezers in conditioned space are summarized in Table 6 below:

Measure	Reference Total Volume (ft^3)	Case	Rated Annual UEC (kWh)
Energy Star® Refrigerator: Bottom Mount Freezer without through-the-door ice - small (8-16.5 ft3 TV)	12.25	Customer Average	518
		Code Baseline	518
		Measure	447
Energy Star® Refrigerator: Bottom Mount Freezer without through-the-door ice - large (16.5-25 ft3 TV)	20.75	Customer Average	573
		Code Baseline	573
		Measure	487
Energy Star® Refrigerator: Top Mount Freezer without through-the-door ice - small (10-15 ft3 TV)	12.50	Customer Average	621
		Code Baseline	420
		Measure	357
Energy Star® Refrigerator: Top Mount Freezer without through-the-door ice - medium (15-20 ft3 TV)	17.50	Customer Average	652
		Code Baseline	469
		Measure	399
Energy Star® Refrigerator: Top Mount Freezer without through-the-door ice - large (20-25 ft3 TV)	23.00	Customer Average	697
		Code Baseline	532
		Measure	452
Energy Star® Refrigerator: Side Mount Freezer without through-the-door ice - medium (15-23 ft3 TV)	19.00	Customer Average	703
		Code Baseline	620
		Measure	528
Energy Star® Refrigerator: Side Mount Freezer without through-the-door ice - large (23-31ft3 TV)	27.00	Customer Average	921
		Code Baseline	665
		Measure	565
Energy Star® Refrigerator: Side Mount Freezer with through-the-door ice - medium (15-23 ft3 TV)	19.00	Customer Average	835
		Code Baseline	639
		Measure	543
Energy Star® Refrigerator: Side Mount Freezer with through-the-door ice - large (23-31 ft3 TV)	27.00	Customer Average	821
		Code Baseline	730
		Measure	620
Energy Star® Freezer: Upright - automatic defrost	18.00	Customer Average	849
		Code Baseline	713
		Measure	642
Energy Star® Freezer: Upright - manual defrost	15.00	Customer Average	708
		Code Baseline	454
		Measure	409
Energy Star® Freezer: Chest - manual defrost	15.00	Customer Average	700
		Code Baseline	409
		Measure	368

Notes to Table:

1. Reference Total Volume based on review of raw CLASS data (RLW 2005[8]) and reclassifying into DEER measure groups and calculating volume weighted average.
2. Code Baseline calculated according to California Title 20 efficiency requirements for the reference volume and type of refrigerator or freezer
3. Measure UEC is 15% less than Code Baseline UEC

Table 6: Refrigerator and Freezer Replacement Descriptions

[7] RLW Analytics, Inc. "2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study", Final Report, prepared for California's Investor Owned Utilities, June 2, 2005.
[8] ibid

2. Refrigerator/Freezer Recycling

a. Refrigerator/Freezer Recycling – Conditioned Space

These two measures estimate the impact of recycling an old refrigerator or freezer that is well past its useful life and completely removing it from service. The measures represent the removal from service of a second refrigerator or a single freezer that is located in conditioned space. These measures have only customer savings. Customer average unit energy consumption (UEC) values are from ADM 2005[9]

b. Refrigerator/Freezer Recycling plus Replacement – Conditioned Space

These two measures estimate the impact of recycling an old refrigerator or freezer that is well past its useful life, removing it from service and replacing it with a more efficient, though not new, appliance. The measures represent the replacement of a second refrigerator or a single freezer that is located in conditioned space. These measures have only customer savings since both units are assumed to be used. Customer average UECs are from ADM 2005[10]

c. Refrigerator/Freezer Recycling – Unconditioned Space

These two measures estimate the impact of recycling an old refrigerator or freezer that is well past its useful life and completely removing it from service. The measures represent the removal from service of a second refrigerator or a single freezer that is located in unconditioned space. These measures have only customer savings. Customer average UECs are from ADM 2005[11]

d. Refrigerator/Freezer Recycling plus Replacement – Unconditioned Space

These two measures estimate the impact of recycling an old refrigerator or freezer that is well past its useful life, removing it from service and replacing it with a more efficient, though not new, appliance. The measures represent the replacement of a second refrigerator or a single freezer that is located in unconditioned space. These measures have only customer savings since both units are assumed to be used. Customer average UECs are from ADM 2005[12]

---

[9] ADM Associates, Inc., "Evaluation Study Of The 2004-05 Statewide Residential Appliance Recycling Program, Final Report", prepared for the California Public Utilities Commission, April 2008

[10] ADM Associates, Inc., "Evaluation Study Of The 2004-05 Statewide Residential Appliance Recycling Program, Final Report", prepared for the California Public Utilities Commission, April 2008

[11] ibid

[12] ibid

Refrigerator and freezer recycling measures are summarized in Table 7 below:

Measure	Case	Rated UEC (kWh)	Source (see Table Notes)
Refrigerator: remove and recycle	Customer Average	1655	1
	Measure	0	
Refrigerator: remove, recycle and replace	Customer Average	1655	1
	Measure	669	2
Freezer: remove and recycle	Customer Average	1257	1
	Measure	0	
Freezer: remove, recycle and replace	Customer Average	1257	1
	Measure	560	3

Notes to Table:

1. See Table 2-6 of ADM 2005[13], weighted average UEC for refrigerators, adjusted for units that are not running or only running part of the time.
2. UEC for replacement refrigerator is assumed to match the baseline refrigerator UEC used for the single family prototype
3. See Table 102 of RLW 2005[14]. Used UEC for all freezers, adjusted for units that are not running or only running part of the time.

Table 7: Refrigerator and Freezer Recycling Measure Summary

C. Duct Sealing and Refrigerant Charge

Duct sealing measures are defined the same as in DEER 2005. Refrigerant charge measures are now divided into four categories:

- at least 20% undercharged
- less than 20% undercharge
- less than 20% overcharged
- at least 20% overcharged

D. High Efficiency Air Conditioning

The 2005 DEER analysis took advantage of significant research that developed typical families of performance curves to represent the various SEER ratings of each air conditioning measure[15]. This set of performance curves has been recently updated to include updated manufacturers' published data as well as the entrance into the market of SEER 18 and SEER 20 air conditioners. Additionally, the SEER 14 unit selection was updated to utilize alternative units rather than a single unit to provide more reasonable median performance across the state sixteen climate zones; one unit was selected as the median performer for CZ 1-7 and another unit was selected as the median performer for CZ 8-16.

E. High Efficiency Water Heaters

The 2005 DEER used simplified engineering calculations to estimate savings from high efficiency water heaters. The 2008 DEER estimates water heater savings by

[13] ibid
[14] RLW Analytics, Inc. "2005 California Statewide Residential Lighting and Appliance Efficiency Saturation Study", Final Report, prepared for California's Investor Owned Utilities, June 2, 2005.
[15] Southern California Edison, "DEER Residential SEER-Rated Units Performance Maps", February 2005

incorporating the domestic hot water system into the residential simulation prototypes.

Efficiency levels for water heaters were based on tier levels established by the Consortium for Energy Efficiency[16]. Current CEE tier definitions are Table 8.

	Storage ≤75,000 Btuh
Tier 0	≥0.62 EF
Tier 1	≥0.67 EF
Tier 2	≥0.80 EF
	Tankless >50,000 and <200,000 Btuh
Tier 1	≥0.82 EF (w/electronic ignition)

Table 8: Energy Efficient Water Heater Performance

The customer average (CA) gas water heater efficiencies were developed from a review of CLASS and are listed in Table 9.

Volume (gallons)	Reference Volume	<1978	1978-1992	1993-2001	2002-2005	>2005 (T24)
<=35	30	0.570	0.570	0.570	0.580	0.613
36-45	40	0.570	0.570	0.570	0.580	0.594
46-55	50	0.570	0.570	0.570	0.575	0.575
56-65	60	0.556	0.556	0.556	0.556	0.556
>65	75	0.480	0.480	0.480	0.480	0.528

Table 9: Customer Average Water Heater Performance

A review of the California small gas water heater database revealed no currently manufactured water heaters meeting Tier 3 for storage water heaters. There were very few water heaters exceeding 0.70 EF. Measure efficiency levels for small gas water heaters are listed in Table 10.

Volume (gallons)	Reference Volume	Level 1	Level 2	Level 3
<=35	30	0.620	0.650	0.700
36-45	40	0.620	0.670	0.700
46-55	50	0.620	0.670	0.700
56-65	60	0.620	0.660	0.700
>65	75	0.620	0.660	0.700

Table 10: Water Heater Performance

[16] Consortium for Energy Efficiency, "High-efficiency specifications for Residential Gas Storage and Tankless Water Heaters" © Consortium for Energy Efficiency

Energy factor is a combined efficiency value intended to take into account standby losses, pilot light energy use and burner efficiency. Proper hourly simulation requires separate simulation of burner efficiency (recovery efficiency) and standby losses. Table 11 lists the recovery efficiencies corresponding to each energy factor used in the simulations.

Reference Volume	Energy Factor	Recovery Efficiency	**Notes**(based on review of California database of gas small storage water heaters)
30	0.570	0.758	Use code baseline RE, assume worse standby loss
	0.580	0.758	Use 2005 code baseline RE, assume worse standby loss
	0.613	0.758	2005 code baseline, CEC average, 0.61 EF, 30 gal
	0.620	0.770	CEC average, 0.62 EF, 30 gal
	0.650	0.810	None in CEC database, from 0.65 EF, 40 gal
	0.700	0.810	None in CEC database, from 0.70 EF, 40 Gal
40	0.570	0.758	Use 2005 code baseline RE, assume worse standby loss
	0.580	0.758	Use 2005 code baseline RE, assume worse standby loss
	0.594	0.758	2005 code baseline, CEC average, 0.59 & 0.60 EF, 40 gal
	0.620	0.770	CEC average, 0.62 EF, 40 gal
	0.670	0.810	4 units in database, all with 0.82 RE, assume 0.81
	0.700	0.810	3 units in database, all with 0.81 RE
50	0.570	0.763	Use code baseline RE, assume worse standby loss
	0.575	0.763	2005 Code baseline, CEC average, 0.57 & 0.58 EF, 50 gal
	0.620	0.774	CEC average, 0.62 EF, 50 gal
	0.670	0.810	CEC average, 0.78 & 0.68 EF, 50 gal
	0.700	0.810	None in CEC database, from 0.70 EF, 40 gal
60	0.556	0.760	2005 Code baseline, CEC average, 0,.55 & 0.56 EF, 60 gal
	0.620	0.760	All 0.62 EF, 50 gal units in CEC database have 0.76 EF
	0.660	0.810	1 0.66 EF 65 gal unit in database, 0.81 RE
	0.700	0.810	None in CEC database, from 0.70 EF, 50 gal
75	0.480	0.760	Use code baseline RE, assume worse standby loss
	0.528	0.760	2005 code baseline, CEC average, 0.53 EF, 75
	0.620	0.800	CEC average, 0.62 EF, 75 gal
	0.660	0.810	None in CEC database, from 0.66 EF, 60 gal
	0.700	0.810	None in CEC database, from 0.70 EF, 40 gal

Table 11: Model Water Heater Performance

DOE-2 inputs are Heat Input Ratio and Tank UA, and part load performance, documented below[17].

HIR (Heat Input Ratio) = 1 / Recovery Efficiency

[17] *"Building America Research Benchmark Definition, Updated December 20, 2007",* United States Department of Energy, Building Technologies Program; NREL/TP-550-42662

$$TANK-UA(Tank\,Losses) = \frac{\left(\frac{1}{EF}-\frac{1}{RE}\right)}{67.5\times\left(\frac{24}{41{,}904}-\frac{1}{RE\times P_{on}}\right)}$$

Where:

UA	=	standby heat loss efficient (Btu/hr-°F)
RE	=	recovery efficiency
P_{on}	=	water heater input (Btu/hr)
67.5	=	temperature difference between storage set point and ambient air temperature at the DOE test condition (°F)
41,094	=	standard daily recovery load at DOE test condition (Btu/day).

Water Heater Part Load Performance:

```
DHW-CURVE = CURVE-FIT
   TYPE              = LINEAR
   INPUT-TYPE        = COEFFICIENTS
   COEFFICIENTS      = ( 0, 1 )
   ..
```

IV. GENERAL REVISIONS – NONRESIDENTIAL BUILDINGS

A. Building Operation

For some buildings, prototypical occupancy schedules and HVAC operation schedules were revised to slightly increase operational hours. In some of the 2005 DEER prototypes, fan operating schedules did not align correctly with building occupancy profiles. In those cases, the models have hours when spaces are occupied, either in the morning, the evening or both, when fans are off. These schedules have been revised so that HVAC operation schedules align with occupancy schedules.

B. Annual Simulation for System Sizing Instead of Design Days

In 2005, HVAC systems were sized using Design Days defined for a 7-day sequence (dates depends on CZ). In prototypes with larger amounts of south glass, this causes terminals in south zones to be undersized. To eliminate this problem, 2008 DEER sizing uses an annual weather file simulation.

C. Reconfiguration of Some Building Prototypes

Several prototypes have been revised to improve their orientation neutrality, as described below:

Assembly:	Split office, currently located in only one corner of the building, to be equally distributed to two opposite corners
Hotel:	Duplicated entire building and rotated 90 degrees.
Motel:	Duplicated entire building and rotated 90 degrees.
Hospital:	Duplicated entire building and rotated 90 degrees.
Nursing Home:	Duplicated entire building and rotated 90 degrees.
Sit Down Restaurant:	Duplicated entire building and rotated 180 degrees.
Fast Food Restaurant:	Duplicated current building and rotated 180 degrees.
Small Retail:	Copied building three times and rotated 90 degrees each time.
Large 3-Story Retail:	Revised to be a generic perimeter/core zoning with blended activity areas similar to the Office and Bio-Tech Manufacturing prototypes.

The University prototype was reduced from four instructional buildings to two. This has significantly improved processing time without affecting the orientation neutrality of the original prototype.

D. Interior Lighting

The 2005 DEER interior lighting approach consisted of the following “three-step” process intended to target estimated EUIs used by utilities:

Step 1: Lighting usage profiles were based on previous (1994 and 2001) DEER simulations as well as values used in CANCCalc, an analysis software used for utility whole building efficiency analysis.
Step 2: Lighting power densities in Watts/ft^2 (LPD) by prototype activity area were based on historical Title 24 maximums
Step 3: Multipliers were applied to all lighting profiles that resulted in simulated end use intensities (EUI) that matched the utility estimated EUIs.

Lighting systems were simulated assuming only one fixture type operating under a single profile. The 2005 approach was adequate for simulating prototypical lighting power and operating conditions, it did not support the analysis of specific lighting measures such as replacement of incandescent with compact fluorescent lamps (CFL) or T-12 with T-8 lamps.

For the 2008 DEER update, LPDs were determined from review of the physical CEUS data by building type and aligning to the DEER prototypes. Separate lighting profiles and LPDs were developed and simulated for the following four lighting fixture categories:

1. Primary General Lighting – representing the predominant fixture type used for general or ambient lighting in a space. This is typically a linear fluorescent fixture but may be a high-bay, high intensity discharge (HID) fixture in some cases such as warehouses.
2. Secondary General Lighting – representing the next most common fixture type used for general lighting in a space. This is typically an incandescent or CFL fixture.
3. Specialty Lighting – representing any lighting fixtures that don't fit into the first two categories and are not exit signs.
4. Exit Signs – these are unique fixtures because they are always on in all building types and therefore must always be simulated as "always on."

Additionally, 2005 DEER lighting profiles were modified to achieve annual full load hours that were more alligned with the most recent M&V lighting monitoring research, mainly the 2002-2003 and 2004-2005 state-wide express efficiency lighting logger studies. These M&V lighting logger study data sets showed that CFL operating hours and resulting equivalent full load hours (EFLH) were quite different and often lower than linear fluorescent and other general lighting.

Table 12 below lists the LPDs used in 2008 by space use.

		Lighting Power Density By Vintage				
Building Type	**Space Use Type**	**Before 1978**	**1978 - 1992**	**1993 - 2001**	**2002 - 2005**	**After 2005**
Retail - Small	Retail - Small - Retail Sales and Wholesale Showroom	1.90	1.90	1.90	1.90	1.90
Office - Small	Office - Small - Office (Executive/Private)	1.70	1.70	1.60	1.60	1.30
Office - Large	Office - Large - Office (Executive/Private)	1.60	1.60	1.50	1.50	1.30
Office - Large	Office - Large - Office (Open Plan)	1.40	1.40	1.40	1.40	1.20
All Others	All Others	0.80	0.80	0.60	0.60	0.60
All Others	Auditorium	1.50	1.50	1.50	1.20	1.20
All Others	Auto Repair Workshop	1.20	1.20	1.20	1.20	1.10
All Others	Bar, Cocktail Lounge	1.10	1.10	1.10	1.10	1.10
All Others	Classroom/Lecture	1.60	1.60	1.60	1.20	1.20
All Others	Comm/Ind Work (General, High Bay)	1.90	1.90	1.30	1.30	1.20
All Others	Comm/Ind Work (General, Low Bay)	1.80	1.80	1.20	1.20	1.20
All Others	Comm/Ind Work (High Tech, Bio Tech, Lab)	1.50	1.50	1.50	1.50	1.30
All Others	Comm/Ind Work (Loading Dock)	1.50	1.50	1.00	1.00	1.00
All Others	Comm/Ind Work (Precision)	1.50	1.50	1.50	1.50	1.30
All Others	Computer Room (Instructional/PC Lab)	1.60	1.60	1.60	1.60	1.20
All Others	Computer Room (Mainframe/Server)	1.50	1.50	1.30	1.30	1.20
All Others	Conference Room	1.80	1.80	1.60	1.50	1.40
All Others	Convention and Meeting Center	1.80	1.80	1.60	1.50	1.40
All Others	Copy Room (photocopying equipment)	1.30	1.30	1.30	1.30	1.20
All Others	Corridor	0.80	0.80	0.60	0.60	0.60
All Others	Dining Area	1.50	1.50	1.30	1.30	1.30
All Others	Exercising Centers and Gymnasium	1.20	1.20	1.00	1.00	1.00
All Others	Hotel/Motel Guest Room (incl. toilets)	0.80	0.80	0.80	0.80	0.80
All Others	Kitchen and Food Preparation	1.70	1.70	1.70	1.70	1.60
All Others	Laboratory, Medical	1.50	1.50	1.50	1.50	1.30
All Others	Laundry	1.50	1.50	0.90	0.90	0.90
All Others	Lobby (Hotel)	1.80	1.80	1.80	1.80	1.10
All Others	Lobby (Main Entry and Assembly)	1.50	1.50	1.50	1.50	1.50
All Others	Lobby (Office Reception/Waiting)	1.60	1.60	1.25	1.25	1.25
All Others	Mall, Arcade and Atrium	1.50	1.20	1.20	1.20	1.20
All Others	Mechanical/Electrical Room	1.50	1.50	0.70	0.70	0.70
All Others	Medical and Clinical Care	1.40	1.40	1.40	1.40	1.20
All Others	Office (Executive/Private)	1.30	1.30	1.30	1.30	1.20
All Others	Office (General)	1.30	1.30	1.30	1.30	1.30
All Others	Office (Open Plan)	1.50	1.50	1.30	1.30	1.20
All Others	Restrooms	0.80	0.80	0.60	0.60	0.60
All Others	Retail Sales and Wholesale Showroom	1.60	1.60	1.60	1.50	1.50
All Others	Retail Sales, Grocery	1.60	1.60	1.60	1.50	1.50
All Others	Storage (Conditioned)	0.80	0.80	0.60	0.60	0.60
All Others	Storage (Unconditioned)	0.80	0.80	0.60	0.60	0.60
All Others	Vocational Areas	2.00	2.00	2.00	2.00	1.20

Table 12: Lighting Power Densities by Space Use

Table 13 below lists the fraction of each lighting fixture type by building and space use.

		Relative proportion of lighting fixture type			
Building Type	Space Use	Primary General Lighting (T12/T8/T5 or HID)	Secondary General Lighting (Incand. or CFL)	Specialty Lighting	Exit Signs
Assembly	all	0.565	0.385	0.043	0.007
Education - Primary School	all	0.922	0.067	0.005	0.007
Education - Secondary School	Exercising Centers and Gymnasium	0.875	0.083	0.037	0.004
Education - Secondary School	all others	0.875	0.083	0.037	0.004
Education - Community College	Exercising Centers and Gymnasium	0.884	0.084	0.029	0.003
Education - Community College	all others	0.884	0.084	0.029	0.003
Education - University	Hotel/Motel Guest Room (incl. toilets)	0.909	0.080	0.007	0.005
Education - University	all others	0.909	0.080	0.007	0.005
Education - Relocatable Classroom	all	0.922	0.067	0.005	0.007
Health/Medical - Hospital	all	0.873	0.094	0.029	0.004
Health/Medical - Nursing Home	all	0.415	0.532	0.044	0.008
Lodging - Hotel	Exercising Centers and Gymnasium	0.246	0.689	0.056	0.009
Lodging - Hotel	Bar, Cocktail Lounge	0.246	0.689	0.056	0.009
Lodging - Hotel	Hotel/Motel Guest Room (incl. toilets)	0.248	0.695	0.056	0.000
Lodging - Hotel	Dining Area	0.246	0.689	0.056	0.009
Lodging - Hotel	all others	0.246	0.689	0.056	0.009
Lodging - Motel	Exercising Centers and Gymnasium	0.293	0.641	0.044	0.023
Lodging - Motel	Hotel/Motel Guest Room (incl. toilets)	0.299	0.656	0.045	0.000
Lodging - Motel	all others	0.293	0.641	0.044	0.023
Manufacturing - Bio/Tech	all	0.769	0.208	0.019	0.004
Manufacturing - Light Industrial	all	0.818	0.104	0.070	0.008
Office - Large	all	0.899	0.072	0.023	0.006
Office - Small	all	0.780	0.161	0.053	0.007
Restaurant - Sit-Down	Dining Area	0.386	0.493	0.110	0.011
Restaurant - Sit-Down	Lobby (Main Entry and Assembly)	0.386	0.493	0.110	0.011
Restaurant - Sit-Down	Kitchen and Food Preparation	0.750	0.125	0.110	0.015
Restaurant - Sit-Down	all others	0.386	0.493	0.110	0.011
Restaurant - Fast-Food	Kitchen and Food Preparation	0.750	0.125	0.110	0.015
Restaurant - Fast-Food	all others	0.653	0.255	0.081	0.011
Retail - Multistory Large	Office (General)	0.844	0.058	0.096	0.003
Retail - Multistory Large	Storage (Conditioned)	0.844	0.058	0.096	0.003
Retail - Multistory Large	all others	0.844	0.058	0.096	0.003
Retail - Single-Story Large	Kitchen and Food Preparation	0.748	0.225	0.025	0.002
Retail - Single-Story Large	all others	0.748	0.225	0.025	0.002
Retail - Small	Storage (Conditioned)	0.620	0.170	0.208	0.002
Retail - Small	all others	0.620	0.170	0.208	0.002
Storage - Conditioned	all	0.732	0.257	0.008	0.002
Storage - Unconditioned	all	0.844	0.151	0.002	0.003

Table 13: Lighting Fixture Type by Building and Space Use.

Table 14 below compares 2005 and 2008 equivalent full load hours for CFL and non-CFL fixtures.

Building Type	Space Use	CFL Equivalent Full Load Hours		Other Lighting Equivalent Full Load Hours	
		2005	2008	2005	2008
Assembly	Auditorium	not incl.	2431	not incl.	2291
Assembly	Office (General)	not incl.	2847	not incl.	2077
Education - Primary School	Classroom/Lecture	1440	2445	1440	2660
Education - Primary School	Exercising Centers and Gymnasium	1440	2051	1440	2434
Education - Primary School	Dining Area	1440	1347	1440	1530
Education - Primary School	Kitchen and Food Preparation	1440	1669	1440	1846
Education - Secondary School	Classroom/Lecture	2305	2445	2305	2608
Education - Secondary School	Office (General)	2305	2323	2305	2452
Education - Secondary School	Exercising Centers and Gymnasium	2305	2366	2305	2532
Education - Secondary School	Computer Room (Instructional/PC Lab)	2305	2137	2305	2522
Education - Secondary School	Dining Area	2305	2365	2305	2493
Education - Secondary School	Kitchen and Food Preparation	2305	1168	2305	1354
Education - Community College	Classroom/Lecture	3792	2471	3792	2619
Education - Community College	Office (General)	3792	2629	3792	2568
Education - Community College	Computer Room (Instructional/PC Lab)	3792	2189	3792	2629
Education - Community College	Comm/Ind Work (General, Low Bay)	3792	3078	3792	2740
Education - Community College	Dining Area	3792	2580	3792	2620
Education - Community College	Kitchen and Food Preparation	3792	2957	3792	2602
Education - University	Classroom/Lecture	3073	2522	3073	2716
Education - University	Office (General)	3073	2870	3073	2640
Education - University	Computer Room (Instructional/PC Lab)	3073	2372	3073	2830
Education - University	Comm/Ind Work (General, Low Bay)	3073	3099	3073	2772
Education - University	Dining Area	3073	2963	3073	2713
Education - University	Kitchen and Food Preparation	3073	3072	3073	2823
Education - University	Hotel/Motel Guest Room (incl. toilets)	3073	1196	3073	1196
Education - University	Corridor	3073	2972	3073	2765
Health/Medical - Hospital	Office (General)	8736	4873	8736	4216
Health/Medical - Hospital	Office (General)	8736	4873	8736	4216
Health/Medical - Hospital	Dining Area	8736	5858	8736	4463
Health/Medical - Hospital	Kitchen and Food Preparation	8736	5858	8736	4463
Health/Medical - Hospital	Medical and Clinical Care	8736	5193	8736	4317
Health/Medical - Hospital	Laboratory, Medical	8736	4257	8736	3449
Health/Medical - Hospital	Medical and Clinical Care	8736	5193	8736	4317
Health/Medical - Hospital	Office (General)	8736	4873	8736	4216
Health/Medical - Nursing Home	Hotel/Motel Guest Room (incl. toilets)	8736	4367	8736	3529
Health/Medical - Nursing Home	Office (General)	8736	3723	8736	3468
Health/Medical - Nursing Home	Office (General)	8736	3723	8736	3468
Health/Medical - Nursing Home	Corridor	8736	7884	8736	4709
Health/Medical - Nursing Home	Dining Area	8736	3814	8736	3522
Health/Medical - Nursing Home	Kitchen and Food Preparation	8736	3814	8736	3522
Lodging - Hotel	Hotel/Motel Guest Room (incl. toilets)	8736	799	1145	799
Lodging - Hotel	Corridor	8736	7884	8736	5913
Lodging - Hotel	Dining Area	8736	3485	8736	3108
Lodging - Hotel	Kitchen and Food Preparation	8736	4524	8736	3641
Lodging - Hotel	Bar, Cocktail Lounge	8736	3820	8736	3275
Lodging - Hotel	Lobby (Hotel)	8736	7884	8736	5913
Lodging - Hotel	Laundry	8736	4154	8736	3586
Lodging - Hotel	Office (General)	8736	3317	8736	3006

Building Type	Space Use	CFL Equivalent Full Load Hours		Other Lighting Equivalent Full Load Hours	
		2005	2008	2005	2008
Lodging - Motel	Hotel/Motel Guest Room (incl. toilets)	8736	755	8736	755
Lodging - Motel	Office (General)	8736	5858	8736	6132
Lodging - Motel	Laundry	8736	4709	8736	4709
Lodging - Motel	Corridor	8736	7474	8736	6132
Manufacturing - Bio/Tech	Laboratory, Medical	not incl.	3177	not incl.	2613
Manufacturing - Bio/Tech	Office (General)	not incl.	3212	not incl.	2613
Manufacturing - Bio/Tech	Corridor	not incl.	7008	not incl.	7008
Manufacturing - Bio/Tech	Computer Room (Mainframe/Server)	not incl.	3068	not incl.	2613
Manufacturing - Bio/Tech	Dining Area	not incl.	3068	not incl.	2847
Manufacturing - Bio/Tech	Kitchen and Food Preparation	not incl.	3068	not incl.	2653
Manufacturing - Bio/Tech	Conference Room	not incl.	3703	not incl.	2676
Manufacturing - Light Industrial	Comm/Ind Work (General, High Bay)	2860	3068	2860	2613
Manufacturing - Light Industrial	Storage (Unconditioned)	2860	3376	2860	2645
Office - Large	Office (Open Plan)	2739	2641	2808	3100
Office - Large	Office (Executive/Private)	2739	2641	2808	3100
Office - Large	Corridor	2739	2641	2808	3860
Office - Large	Lobby (Office Reception/Waiting)	2739	2692	2808	3860
Office - Large	Conference Room	2739	2692	2808	1647
Office - Large	Copy Room (photocopying equipment)	2739	2692	2808	3860
Office - Large	Restrooms	2739	2692	2808	3860
Office - Large	Mechanical/Electrical Room	2739	2692	2808	1647
Office - Small	Office (Executive/Private)	2492	2594	2808	3066
Office - Small	Corridor	2492	2594	2808	3360
Office - Small	Lobby (Office Reception/Waiting)	2492	2594	2808	3957
Office - Small	Conference Room	2492	2594	2808	1556
Office - Small	Copy Room (photocopying equipment)	2492	2594	2808	3957
Office - Small	Restrooms	2492	2594	2808	3957
Office - Small	Mechanical/Electrical Room	2492	2594	2808	1556
Restaurant - Sit-Down	Dining Area	3444	4836	4368	4836
Restaurant - Sit-Down	Lobby (Main Entry and Assembly)	3444	4836	4368	4836
Restaurant - Sit-Down	Kitchen and Food Preparation	3444	4804	4368	4804
Restaurant - Sit-Down	Restrooms	3444	4606	4368	4606
Restaurant - Fast-Food	Dining Area	6188	4850	6188	4850
Restaurant - Fast-Food	Lobby (Main Entry and Assembly)	6188	4850	6188	4850
Restaurant - Fast-Food	Kitchen and Food Preparation	6188	4812	6188	4812
Restaurant - Fast-Food	Restrooms	6188	4677	6188	4677
Retail - 3-Story Large	Retail Sales and Wholesale Showroom	4259	3546	4259	3989
Retail - 3-Story Large	Storage (Conditioned)	4259	2702	4259	2559
Retail - 3-Story Large	Office (General)	4259	2596	4259	2559
Retail - Single-Story Large	Retail Sales and Wholesale Showroom	4368	3546	4368	3989
Retail - Single-Story Large	Storage (Conditioned)	4368	2738	4368	2633
Retail - Single-Story Large	Office (General)	4368	2563	4368	2516
Retail - Single-Story Large	Auto Repair Workshop	4368	3429	4368	4022
Retail - Single-Story Large	Kitchen and Food Preparation	4368	3368	4368	3947
Retail - Single-Story Large	Retail Sales and Wholesale Showroom	4368	3546	4368	3989
Retail - Small	Retail Sales and Wholesale Showroom	3724	3378	4004	4013
Retail - Small	Storage (Conditioned)	3724	2753	4004	2550

Building Type	Space Use	CFL Equivalent Full Load Hours		Other Lighting Equivalent Full Load Hours	
		2005	2008	2005	2008
Storage - Conditioned	Storage (Conditioned)	2860	3441	2860	2780
Storage - Conditioned	Office (General)	2860	3441	2860	2780
Storage - Unconditioned	Storage (Unconditioned)	2860	3441	2860	2780
Storage - Unconditioned	Office (General)	2860	3441	2860	2780
Grocery	Retail Sales, Grocery	2492	4964	2808	3942
Grocery	Office (General)	2492	4526	2808	3504
Grocery	Comm/Ind Work (Loading Dock)	2492	4964	2808	3942
Grocery	Refrigerated (Food Preparation)	2492	4380	2808	3504
Grocery	Refrigerated (Walk-in Freezer)	2492	4380	2808	3504
Grocery	Refrigerated (Walk-in Cooler)	2492	4380	2808	3504
Warehouse – Refrigerated	Refrigerated (Frozen Storage)	2492	4818	2808	4818
Warehouse – Refrigerated	Refrigerated (Cooled Storage)	2492	4818	2808	4818
Warehouse – Refrigerated	Comm/Ind Work (Loading Dock)	2492	4818	2808	4818
Warehouse – Refrigerated	Office (General)	2492	3522	2808	2719

Table 14: Comparison of 2005 and 2008 EFLH for Lighting

E. Development History of Packaged HVAC Performance Maps

1. DEER 2005

The DEER 2005 release developed detailed performance models for residential split-systems only; non-residential models utilized "default" DOE-2 performance maps. The new residential performance maps used in DEER 2005 were based upon "EER & SEER as Predictors of Seasonal Cooling Performance", an SCE 2003 Codes and Standards project, which:

- Selected 88 representative units from a database of over 570 units which spanned the available performance of the market and also provided extended unit performance data. Developed programs to extract detailed performance maps from manufacturers' expanded ratings tables and ARI cycling test results.
- Detailed performance maps were developed for SEER-10, 12, and 14 single-speed split, SEER-15 two-speed split-system, and SEER-10 and 12 packaged air conditioners and heat pumps. A wide range of manufacturers were included in the development of these performance maps.

For DEER 2005, performance maps for SEER 13, 14 and15 single-speed heat pumps and air conditioners were developed along with performance maps for two-speed units up to SEER 18. DOE-2 simulations were performed using the full set of performance maps to identify those units with a given SEER rating which produced median seasonal cooling performance.

2. DEER 2008

Two added SEER/EER research projects were undertaken (separately from the DEER update) that provided a greatly improved knowledge base for small packaged HVAC performance.

First, the Codes and Standards work was updated in 2005-2006 as documented in the "EER & SEER as Predictors of Seasonal Cooling Performance, Updated Report of Commercial Research" and "EER & SEER as Predictors of Seasonal Cooling Performance, Updated Report of Residential Research" reports. The residential update allowed the improvements to the residential split-system models described in a previous section. The small commercial packaged equipment update work added SEER-13 packaged air conditioners and heat pumps to original database. The project findings also established the importance of indoor fan energy on seasonal performance in commercial applications. This finding was used in selecting representative unit in 2008 DEER analyses.

Second, the C&S work, which focused only on SEER rated (very small units without economizers), was augmented by a pair of SCE demand response projects as documented in "PCT Demand Control Study – Phase I Preliminary Evaluation" and "PCT Demand Control Study – Phase II" This study:

- Developed DOE-2 performance curves for ALL SEER-rated packaged A/C units for which data could be found. A wide range of manufacturers were utilized when developing these performance curves.
- Developed DOE-2 performance curves for packaged units including ALL EER-rated A/C units up to 10 tons for which manufacturers' data were available. Again, a wide range of manufacturers were utilized. Developed standard part-load performance curves based on compressor sizes and Stage 1, Stage 2 (S1,S2) thermostat control for multi-compressor packaged units.

Starting with the performance maps obtained from these research projects, the DEER project:

- Expanded the SEER-rated packaged unit database to include newer units for all past manufacturers in the database.
- Expanded the database of EER-rated, up-to 10 ton A/C units to include new data found additional manufacturers.
- Expanded the EER-rated unit database to include ALL packaged A/C units from 10 - 20 tons.

This database of SEER and EER rated packaged units up to 20 tons became the data base from which the non-residential packaged units were selected.

F. Small (less than 20 tons) Package HVAC Performance Modeling

Previous analysis of small ($\leq$20 tons), a single zone package HVAC system was based on the following assumptions:

- General translation of EER to DOE-2's COOLING-EIR following rules set forth in CEC 2004[18]
- COOLING-EIR includes power of condenser fan
- Prototype defined static pressure and fan efficiency
- All other properties and performance characteristics per DOE-2.2 default

For 2008, representative families of performance data were developed for these systems through research and analysis of currently available equipment described in the previous section. Very few DOE-2 properties were defaulted in the 2008 analysis. This "custom" performance detail includes:

- COOLING-EIR that considers only compressor energy
- Explicit input for condenser fan power
- Detailed performance inputs such as total and sensible cooling capacity as well as some cooling coil detail (DOE-2's COOLING-CAPACITY, COOL-SH-CAP and BYPASS-FACTOR keywords)
- Detailed performance curves for the above performance parameters relative to indoor and outdoor conditions
- Indoor fan power based on actual equipment performance, not generic prototypical static pressure and fan efficiency

During review of the 09-11 planning (30 May 2008) release of DEER energy results, the DEER team determined that the small package HVAC cooling efficiency values were about 10% less than intended for all non-HVAC measures on the oldest three vintages of the following prototypes: Assembly, Primary School, Secondary School, Small Office, Large 1-Story Retail, Sit Down Restaurant, Fast Food Restaurant. The error caused the non-HVAC measure results for these older buildings and vintages to be slightly higher than expected.

V. MEASURE REVISIONS – NONRESIDENTIAL BUILDINGS

A. Interior Lighting

Previous interior lighting measures consisted of only two weather sensitive lighting measures – 10% LPD reduction and 40% LPD reduction. These measures were generally not useful since it was impossible to associate economic parameters to these lighting power reductions. In DEER 2005, all fixture specific measures were included in the non-weather sensitive measure group. 2008 lighting analysis consists of 19 CFL replacement measures, 36 linear fluorescent measures, 13 HID measures and 6 exit sign measures. Each of these measures represents the replacement or retrofit of a specific baseline fixture with a measure fixture consuming less power. The current list of fixture replacements covers the fixtures that make up the largest contributions to utilities' program accomplishments to date.

[18] California Energy Commission, "Nonresidential Alternative Calculation Methods Approval Manual", publication #P400-04-004F, October 2004

CFL measures consist of replacements of incandescent lamps in various applications, fixture types and wattages. The absolute, per lamp, wattage reduction is calculated with the following formula:

power reduction = 2.53 * cfl rated power

This value follows the similar values used for residential CFLs; a non-residential field survey or self report data set with more appropriate for characterizing California business (across all business types and sizes as well as geographic location) replacement of incandescent lamps with CFLs is not available at this time.

Linear fluorescent, HID and exit sign lighting power reduction is calculated as the ratio of the measure fixture wattage to the baseline fixture wattage, multiplied by the prototype LPD. Each measure will be mapped to one of the four lighting fixture categories. For example, a linear fluorescent measure only affects the portion of the lighting power in any prototype that represents linear fluorescent fixtures. All other portions of the lighting power will be unchanged. In this way, each measure will have with it not only kWh/fixture and kW/fixture savings, but our best attempt at establishing load shape impacts of the measure.

There are two possible code baselines. First whenever 50% of the fixtures in a space are replaced, Title 24 maximum LPDs must be followed. In these cases the code baseline is the LPD for the 2005 and later vintage.

For fixture replacements not covered by Title 24 LPD requirements, there may be federal or state requirements for the minimum efficiency of the lighting fixture, but no limitation on the LPD. Federal and state requirements for linear fluorescent ballasts, combined with common available technologies, generally mean that the code baseline fixture includes first generation T-8 lamps and electronic ballasts. In these cases, the code baseline LPD is determine by multiplying the baseline LPD times the ratio of code baseline fixture wattage to the baseline fixture wattage.

B. Increased Applicability of HVAC Measures

Measure applicability has been greatly expanded so that HVAC measures are available for many more building types. Table 15 below compares HVAC system applicability between 2005 and 2008.

	System Type							
	Built-Up VAV		Fan Coil		Package VAV		Package Single Zone	
Building Type	2005	2008	2005	2008	2005	2008	2005	2008
Assembly	N	N	N	N	N	N	Y	Y
Education – Primary School	N	N	N	Y	N	N	Y	Y
Ecucation – Secondary School	N	N	Y	Y	N	Y	N	Y
Education – Community College	Y	Y	N	N	N	Y	N	Y
Education – Relocatable Classroom	N	N	N	N	N	N	Y	Y
Health/Medical – Hospital	Y	Y	Y	Y	N	Y	N	Y
Health/Medical – Nursing Hime	Y	Y	Y	Y	N	Y	N	Y
Lodging – Hotel (Public Areas)	Y	Y	N	N	Y	Y	N	Y
Lodging - Hotel (Guest Rooms)	N	N	Y	Y	N	N	N	Y
Lodging – Motel	N	N	N	N	N	N	N	Y
Manufacturing – Bio/Tech	N	Y	N	N	N	N	Y	Y
Manufacturing – Light Industrial	N	N	N	N	N	N	Y	Y
Office – Large	Y	Y	N	N	N	Y	N	Y
Office – Small	N	Y	N	N	N	N	Y	Y
Restaurant – Sit-Down	N	N	N	N	N	N	Y	Y
Restaurant – Fast-Food	N	N	N	N	N	N	Y	Y
Retail – 3-Story Large	Y	Y	N	N	N	Y	N	Y
Retail – Single-Story Large	N	N	N	N	N	N	Y	Y
Retail – Small	N	N	N	N	N	N	Y	Y
Storage - Conditioned	N	N	N	N	N	N	Y	Y

Table 15: HVAC System Applicability

In addition to expanding measure applicability, these prototype revisions also created more realistic applications for package single zone equipment. Many applications of package single zone (PSZ) equipment in 2005 were specialized uses such as cafeterias, kitchens and workshops. Consequently, results reflected use of this equipment in less common applications. The 2008 prototypes are revised so that the particular equipment type serves the entire building, not just one specialized area. The results now reflect more "prototypical" applications of the equipment.

C. Expanded List of Package HVAC Efficiency Measures

The 2008 package air-conditioning measure list consists of three increasing tiers of each of the following size ranges:

- < 65 kBtuh (no economizer)
- ≥ 65 kBtuh and < 90 kBtuh (no economizer)
- ≥ 90 kBtuh and < 135 kBtuh (with economizer)
- ≥ 135 kBtuh and < 240 kBtuh (with economizer)
- ≥ 240 kBtuh and < 760 kBtuh (with economizer)
- ≥ 760 kBtuh (with economizer)

The three efficiency levels correspond to efficiency "tiers" published by the Consortium for Energy Efficiency[19]. All measures for units less than 240 kBtuh utilize the package single zone prototype system and custom HVAC performance details described under "General Revisions – Nonresidential". Care should be taken in examining these results as often a higher SEER or EER rating for a tier might not translate into a positive energy savings. This result is due to the details of manufacturers' equipment specification varying within the different rating tiers. For example, a higher tier quite often may have a more efficient compressor combined with a slightly less efficient fan; this will allow the SEER or EER of the unit to increase, but in the filed application where the fan are required to operate continuously throughout the occupancy period for the full year while the compressor can cycle with the cooling demand, the compressor savings can be more than counter-balanced by the fan energy use increase.

D. Duct Sealing for Small Package HVAC Systems

During review of the 09-11 planning (30 May 2008) release of DEER energy results, the DEER team determined that the Customer Average sizing methodology for the HVAC systems in the nonresidential duct sealing measures was incorrect. Therefore, results for the non-residential duct sealing measures have been temporarily removed from the database. These measures will be added back into the data base for review and comment as soon as the new sizing methodology DEER team review is complete. Definitions for non-residential duct sealing measures will not change.

The duct sealing measures are applicable to buildings with small package HVAC systems (<u><</u>10 tons) with ducts located within an above ceiling plenum or unconditioned space. Baseline and measure performance criteria are based on available research[20, 21]. Measure descriptions are provided in Table 16 below.

Measure	Case	Supply Leakage	Return Leakage	Total Leakage	OSA Fraction of Make-up Air
High Leak Reduction	Customer Avg	20%	20%	40%	20% of return
	Measure	9%	9%	18%	20% of return
Typical Leak Reduction	Customer Avg	14%	14%	28%	20% of return
	Measure	9%	9%	18%	20% of return

Table 16: Non-Residential Duct Sealing Parameters

E. Refrigerant Charge for Small Package HVAC Systems

Refrigerant charge measures are applied to all building types and assume small package HVAC systems (<u><</u>10 tons). HVAC performance modifications are based on the same field measurement data used for residential measures in the 2005 DEER update, expanded to included larger units (>5 tons) in the dataset. The field

[19] Consortium for Energy Efficiency, "CEE Unitary Air-Conditioning Specification", January 2007
[20] Cummings, J. B., C. R. Withers, N. Moyer, P. Fairey, B. McKendry. "Uncontrolled Air Flow in Non-Residential Buildings." FSEC-CR-878-96. 1996.
[21] Delp, W. W., N. E. Matson, E. Tschudy, M. P. Modera, and R. C. Diamond. "Field Investigation of Duct System Performance in California Light Commercial Buildings." 1997.

measurements were performed by HVAC technicians and contractors who performed refrigerant charge measurement and correction services. Modifications to DOE-2 inputs that represent the effects of refrigerant over- or under-charge are listed in Table 17 below.

Measure (% Charge Change)	Simulation Multipliers for Customer Average		
	Total Capacity	Sensible Capacity	Cooling EIR
Decrease ≥ 20%	0.826	0.889	1.347
Decrease < 20%	0.902	0.951	1.150
Increase < 20%	0.884	0.912	1.119
Increase ≥ 20%	0.839	0.907	1.159

Table 17: Non-residential Refrigerant Charge Measure Parameters

During review of the 09-11 planning (30 May 2008) release of DEER energy results, the DEER team discovered an error in the refrigerant charge results that caused negative savings for condenser fan energy (listed as heat rejection energy in MISer). The error caused a larger condenser fan to be simulated for the measure case than the customer average case, causing the heat rejection energy use to increase for the measure compared to the customer average. This error has been corrected and condenser fan sizes are now identical for the customer average and measure cases.

F. Grocery Store Air Leakage Measures

Grocery store lighting and HVAC measures have been added to the data base; these measures utilize modeling methods as described above for other building types. Grocery refrigeration measures are under development and will be documented and are expected to be released for comment within one or two weeks.

Appendix A: DEER2008 Heating and Cooling Thermostat Settings and Weights for Single-Family Building Type

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints				Cooling Temperature Setpoints				Thermostat Weight
			Morning	Day	Evening	Night	Morning	Day	Evening	Night	
CZ01	Before 1978	T1	55	55	55	55	74	74	74	74	0.30
		T2	60	60	60	60	83	76	76	83	0.30
		T3	70	65	65	70	78	78	78	78	0.20
		T4	68	65	65	68	83	80	80	83	0.10
		T5	68	68	68	68	80	80	80	80	0.10
	1978 - 1992	T1	55	55	55	55	74	74	74	74	0.30
		T2	68	65	65	68	83	76	76	83	0.30
		T3	68	68	68	68	78	78	78	78	0.20
		T4	60	60	60	60	83	80	80	83	0.10
		T5	65	65	65	65	80	80	80	80	0.10
	1993 - 2001	T1	55	55	55	55	74	74	74	74	0.30
		T2	65	70	70	65	83	76	76	83	0.30
		T3	60	60	60	60	78	78	78	78	0.20
		T4	68	65	65	68	83	80	80	83	0.10
		T5	68	68	68	68	80	80	80	80	0.10
	2002 - 2005	T1	55	55	55	55	74	74	74	74	0.30
		T2	68	68	68	68	83	76	76	83	0.30
		T3	60	60	60	60	78	78	78	78	0.20
		T4	65	65	65	65	83	80	80	83	0.10
		T5	65	68	68	65	80	80	80	80	0.10
	After 2005	T1	60	60	60	60	74	74	74	74	0.30
		T2	68	65	65	68	83	76	76	83	0.30
		T3	55	55	55	55	78	78	78	78	0.20
		T4	65	70	70	65	83	80	80	83	0.10
		T5	68	68	68	68	80	80	80	80	0.10
CZ02	Before 1978	T1	65	65	65	65	80	80	80	80	0.05
		T2	60	60	60	60	76	83	83	76	0.10
		T3	65	68	68	65	80	83	83	80	0.10
		T4	55	55	55	55	83	83	83	83	0.30
		T5	68	65	65	68	90	90	90	90	0.45
	1978 - 1992	T1	68	65	65	68	78	78	78	78	0.15
		T2	60	60	60	60	83	80	80	83	0.10
		T3	68	68	68	68	76	83	83	76	0.30
		T4	65	70	70	65	83	83	83	83	0.25
		T5	70	65	65	70	90	90	90	90	0.20
	1993 - 2001	T1	65	68	68	65	78	78	78	78	0.10
		T2	65	70	70	65	80	80	80	80	0.10
		T3	65	65	65	65	76	83	83	76	0.20
		T4	55	55	55	55	83	83	83	83	0.30
		T5	60	60	60	60	90	90	90	90	0.30
	2002 - 2005	T1	60	60	60	60	83	76	76	83	0.20
		T2	70	65	65	70	78	78	78	78	0.30
		T3	65	65	65	65	80	80	80	80	0.20
		T4	65	68	68	65	76	83	83	76	0.20
		T5	55	55	55	55	80	83	83	80	0.10
	After 2005	T1	65	65	65	65	74	74	74	74	0.10
		T2	68	65	65	68	83	76	76	83	0.35
		T3	65	70	70	65	78	78	78	78	0.25
		T4	65	68	68	65	83	80	80	83	0.15
		T5	68	68	68	68	80	80	80	80	0.15
CZ03	Before 1978	T1	68	68	68	68	83	76	76	83	0.10
		T2	60	60	60	60	78	78	78	78	0.20
		T3	65	65	65	65	83	80	80	83	0.20
		T4	68	65	65	68	80	80	80	80	0.20
		T5	65	68	68	65	76	83	83	76	0.30
	1978 - 1992	T1	70	70	70	70	74	74	74	74	0.10
		T2	68	65	65	68	83	76	76	83	0.25
		T3	65	65	65	65	78	78	78	78	0.20
		T4	70	65	65	70	83	80	80	83	0.20
		T5	68	68	68	68	80	80	80	80	0.25
	1993 - 2001	T1	65	70	70	65	83	76	76	83	0.15
		T2	68	68	68	68	78	78	78	78	0.30
		T3	60	60	60	60	83	80	80	83	0.20
		T4	68	65	65	68	80	80	80	80	0.20
		T5	70	65	65	70	76	83	83	76	0.15
	2002 - 2005	T1	60	60	60	60	83	76	76	83	0.15
		T2	68	65	65	68	78	78	78	78	0.30
		T3	65	68	68	65	83	80	80	83	0.20
		T4	68	68	68	68	80	80	80	80	0.20
		T5	65	65	65	65	76	83	83	76	0.15
	After 2005	T1	60	60	60	60	74	74	74	74	0.05
		T2	68	65	65	68	83	76	76	83	0.20
		T3	65	70	70	65	78	78	78	78	0.30
		T4	68	68	68	68	83	80	80	83	0.30
		T5	65	68	68	65	80	80	80	80	0.15

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints Morning	Heating Day	Heating Evening	Heating Night	Cooling Temperature Setpoints Morning	Cooling Day	Cooling Evening	Cooling Night	Thermostat Weight
CZ04	Before 1978	T1	60	60	60	60	78	78	78	78	0.20
		T2	65	65	65	65	83	80	80	83	0.30
		T3	65	68	68	65	80	80	80	80	0.20
		T4	65	70	70	65	76	83	83	76	0.20
		T5	55	55	55	55	80	83	83	80	0.10
	1978 - 1992	T1	70	65	65	70	74	74	74	74	0.10
		T2	60	60	60	60	83	76	76	83	0.15
		T3	68	68	68	68	78	78	78	78	0.30
		T4	65	70	70	65	83	80	80	83	0.20
		T5	68	65	65	68	80	80	80	80	0.25
	1993 - 2001	T1	65	65	65	65	83	76	76	83	0.10
		T2	68	65	65	68	78	78	78	78	0.30
		T3	60	60	60	60	83	80	80	83	0.25
		T4	68	68	68	68	80	80	80	80	0.25
		T5	65	68	68	65	76	83	83	76	0.10
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.20
		T2	65	65	65	65	83	76	76	83	0.35
		T3	68	65	65	68	78	78	78	78	0.25
		T4	55	55	55	55	83	80	80	83	0.10
		T5	60	60	60	60	80	80	80	80	0.10
	After 2005	T1	65	68	68	65	74	74	74	74	0.40
		T2	65	65	65	65	83	76	76	83	0.35
		T3	68	65	65	68	78	78	78	78	0.10
		T4	68	68	68	68	83	80	80	83	0.10
		T5	60	60	60	60	80	80	80	80	0.05
CZ05	Before 1978	T1	60	60	60	60	78	78	78	78	0.10
		T2	68	68	68	68	83	80	80	83	0.10
		T3	68	65	65	68	80	80	80	80	0.35
		T4	65	68	68	65	76	83	83	76	0.20
		T5	65	70	70	65	83	83	83	83	0.25
	1978 - 1992	T1	65	65	65	65	83	76	76	83	0.20
		T2	65	70	70	65	78	78	78	78	0.10
		T3	70	65	65	70	83	80	80	83	0.20
		T4	68	65	65	68	80	80	80	80	0.25
		T5	68	68	68	68	76	83	83	76	0.25
	1993 - 2001	T1	65	70	70	65	83	76	76	83	0.10
		T2	68	65	65	68	78	78	78	78	0.15
		T3	70	65	65	70	83	80	80	83	0.35
		T4	68	68	68	68	80	80	80	80	0.30
		T5	70	70	70	70	76	83	83	76	0.10
	2002 - 2005	T1	65	65	65	65	83	76	76	83	0.10
		T2	68	68	68	68	78	78	78	78	0.20
		T3	68	65	65	68	83	80	80	83	0.35
		T4	65	70	70	65	80	80	80	80	0.25
		T5	65	68	68	65	76	83	83	76	0.10
	After 2005	T1	70	65	65	70	83	76	76	83	0.15
		T2	68	65	65	68	78	78	78	78	0.35
		T3	65	70	70	65	83	80	80	83	0.20
		T4	68	68	68	68	80	80	80	80	0.20
		T5	65	68	68	65	76	83	83	76	0.10
CZ06	Before 1978	T1	60	60	60	60	74	74	74	74	0.10
		T2	65	68	68	65	83	76	76	83	0.20
		T3	65	70	70	65	78	78	78	78	0.30
		T4	68	65	65	68	83	80	80	83	0.20
		T5	68	68	68	68	80	80	80	80	0.20
	1978 - 1992	T1	68	65	65	68	74	74	74	74	0.20
		T2	70	65	65	70	83	76	76	83	0.20
		T3	70	70	70	70	78	78	78	78	0.15
		T4	60	60	60	60	83	80	80	83	0.10
		T5	68	68	68	68	83	83	83	83	0.35
	1993 - 2001	T1	68	65	65	68	74	74	74	74	0.20
		T2	70	65	65	70	83	76	76	83	0.20
		T3	68	68	68	68	78	78	78	78	0.25
		T4	70	70	70	70	83	80	80	83	0.20
		T5	60	60	60	60	80	80	80	80	0.15
	2002 - 2005	T1	68	65	65	68	74	74	74	74	0.20
		T2	68	68	68	68	83	76	76	83	0.35
		T3	70	65	65	70	78	78	78	78	0.20
		T4	60	60	60	60	83	80	80	83	0.10
		T5	65	70	70	65	80	80	80	80	0.15
	After 2005	T1	68	68	68	68	74	74	74	74	0.40
		T2	70	65	65	70	83	76	76	83	0.35
		T3	60	60	60	60	78	78	78	78	0.10
		T4	65	68	68	65	83	80	80	83	0.10
		T5	70	70	70	70	80	80	80	80	0.05

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints Morning	Heating Day	Heating Evening	Heating Night	Cooling Temperature Setpoints Morning	Cooling Day	Cooling Evening	Cooling Night	Thermostat Weight
CZ07	Before 1978	T1	65	68	68	65	83	76	76	83	0.10
		T2	60	60	60	60	78	78	78	78	0.20
		T3	65	70	70	65	83	80	80	83	0.30
		T4	68	65	65	68	80	80	80	80	0.30
		T5	68	68	68	68	76	83	83	76	0.10
	1978 - 1992	T1	65	68	68	65	74	74	74	74	0.10
		T2	65	70	70	65	83	76	76	83	0.15
		T3	68	65	65	68	78	78	78	78	0.25
		T4	68	68	68	68	80	80	80	80	0.35
		T5	70	70	70	70	76	83	83	76	0.15
	1993 - 2001	T1	70	70	70	70	74	74	74	74	0.10
		T2	68	65	65	68	83	76	76	83	0.15
		T3	60	60	60	60	78	78	78	78	0.20
		T4	70	65	65	70	80	80	80	80	0.20
		T5	68	68	68	68	76	83	83	76	0.35
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.45
		T2	68	65	65	68	83	76	76	83	0.35
		T3	65	65	65	65	78	78	78	78	0.10
		T4	60	60	60	60	83	80	80	83	0.05
		T5	68	68	68	68	80	80	80	80	0.05
	After 2005	T1	65	70	70	65	74	74	74	74	0.45
		T2	68	65	65	68	83	76	76	83	0.35
		T3	70	65	65	70	78	78	78	78	0.10
		T4	60	60	60	60	83	80	80	83	0.05
		T5	65	65	65	65	80	80	80	80	0.05
CZ08	Before 1978	T1	60	60	60	60	74	74	74	74	0.10
		T2	68	65	65	68	78	78	78	78	0.10
		T3	68	68	68	68	83	80	80	83	0.20
		T4	65	68	68	65	76	83	83	76	0.30
		T5	65	70	70	65	80	83	83	80	0.30
	1978 - 1992	T1	70	70	70	70	74	74	74	74	0.10
		T2	65	65	65	65	83	76	76	83	0.15
		T3	68	65	65	68	78	78	78	78	0.15
		T4	68	68	68	68	83	80	80	83	0.30
		T5	70	65	65	70	80	83	83	80	0.30
	1993 - 2001	T1	70	65	65	70	74	74	74	74	0.10
		T2	65	68	68	65	83	76	76	83	0.25
		T3	70	70	70	70	78	78	78	78	0.10
		T4	68	65	65	68	83	80	80	83	0.25
		T5	68	68	68	68	80	80	80	80	0.30
	2002 - 2005	T1	68	65	65	68	74	74	74	74	0.45
		T2	65	70	70	65	83	76	76	83	0.35
		T3	68	68	68	68	78	78	78	78	0.10
		T4	60	60	60	60	83	80	80	83	0.05
		T5	65	65	65	65	80	80	80	80	0.05
	After 2005	T1	68	65	65	68	74	74	74	74	0.45
		T2	65	70	70	65	83	76	76	83	0.35
		T3	70	65	65	70	78	78	78	78	0.10
		T4	65	65	65	65	83	80	80	83	0.05
		T5	65	68	68	65	80	80	80	80	0.05
CZ09	Before 1978	T1	65	65	65	65	83	76	76	83	0.10
		T2	68	68	68	68	78	78	78	78	0.20
		T3	65	70	70	65	83	80	80	83	0.30
		T4	68	65	65	68	76	83	83	76	0.30
		T5	65	68	68	65	85	85	85	85	0.10
	1978 - 1992	T1	72	72	72	72	78	78	78	78	0.20
		T2	68	68	68	68	83	80	80	83	0.30
		T3	70	65	65	70	80	80	80	80	0.30
		T4	65	70	70	65	76	83	83	76	0.10
		T5	68	65	65	68	85	85	85	85	0.10
	1993 - 2001	T1	65	68	68	65	74	74	74	74	0.15
		T2	68	65	65	68	83	76	76	83	0.15
		T3	70	65	65	70	78	78	78	78	0.20
		T4	70	70	70	70	83	80	80	83	0.20
		T5	68	68	68	68	76	83	83	76	0.30
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.10
		T2	68	68	68	68	83	76	76	83	0.35
		T3	68	65	65	68	78	78	78	78	0.30
		T4	70	70	70	70	83	80	80	83	0.20
		T5	65	65	65	65	80	80	80	80	0.05
	After 2005	T1	68	68	68	68	74	74	74	74	0.45
		T2	70	65	65	70	83	76	76	83	0.35
		T3	68	65	65	68	78	78	78	78	0.10
		T4	65	70	70	65	83	80	80	83	0.05
		T5	70	70	70	70	80	80	80	80	0.05

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints				Cooling Temperature Setpoints				Thermostat Weight
			Morning	Day	Evening	Night	Morning	Day	Evening	Night	
CZ10	Before 1978	T1	60	60	60	60	83	80	80	83	0.10
		T2	65	68	68	65	76	83	83	76	0.10
		T3	65	65	65	65	80	83	83	80	0.30
		T4	65	70	70	65	85	85	85	85	0.20
		T5	68	68	68	68	90	90	90	90	0.30
	1978 - 1992	T1	68	65	65	68	83	80	80	83	0.20
		T2	65	68	68	65	80	80	80	80	0.15
		T3	72	72	72	72	76	83	83	76	0.15
		T4	70	65	65	70	85	85	85	85	0.30
		T5	68	68	68	68	90	90	90	90	0.20
	1993 - 2001	T1	68	65	65	68	83	76	76	83	0.10
		T2	70	70	70	70	83	80	80	83	0.10
		T3	68	68	68	68	80	80	80	80	0.30
		T4	70	65	65	70	76	83	83	76	0.30
		T5	65	65	65	65	85	85	85	85	0.20
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.10
		T2	68	68	68	68	83	76	76	83	0.20
		T3	70	65	65	70	78	78	78	78	0.35
		T4	70	70	70	70	83	80	80	83	0.20
		T5	68	65	65	68	80	80	80	80	0.15
	After 2005	T1	68	68	68	68	74	74	74	74	0.30
		T2	70	65	65	70	83	76	76	83	0.40
		T3	70	70	70	70	78	78	78	78	0.20
		T4	68	65	65	68	83	80	80	83	0.05
		T5	72	72	72	72	80	80	80	80	0.05
CZ11	Before 1978	T1	60	60	60	60	76	83	83	76	0.20
		T2	65	68	68	65	80	83	83	80	0.20
		T3	65	70	70	65	83	83	83	83	0.20
		T4	55	55	55	55	85	85	85	85	0.30
		T5	68	65	65	68	90	90	90	90	0.10
	1978 - 1992	T1	60	60	60	60	78	78	78	78	0.20
		T2	65	65	65	65	83	80	80	83	0.25
		T3	68	65	65	68	80	80	80	80	0.25
		T4	65	70	70	65	76	83	83	76	0.10
		T5	68	68	68	68	85	85	85	85	0.20
	1993 - 2001	T1	65	68	68	65	83	76	76	83	0.20
		T2	68	65	65	68	78	78	78	78	0.35
		T3	68	68	68	68	83	80	80	83	0.25
		T4	70	65	65	70	80	80	80	80	0.15
		T5	60	60	60	60	76	83	83	76	0.05
	2002 - 2005	T1	65	68	68	65	74	74	74	74	0.15
		T2	60	60	60	60	83	76	76	83	0.35
		T3	65	65	65	65	78	78	78	78	0.25
		T4	65	70	70	65	83	80	80	83	0.15
		T5	68	65	65	68	80	80	80	80	0.10
	After 2005	T1	68	65	65	68	74	74	74	74	0.45
		T2	60	60	60	60	83	76	76	83	0.35
		T3	65	68	68	65	78	78	78	78	0.10
		T4	68	68	68	68	83	80	80	83	0.05
		T5	70	65	65	70	80	80	80	80	0.05
CZ12	Before 1978	T1	68	68	68	68	80	80	80	80	0.10
		T2	65	70	70	65	76	83	83	76	0.15
		T3	55	55	55	55	80	83	83	80	0.20
		T4	60	60	60	60	83	83	83	83	0.25
		T5	65	65	65	65	85	85	85	85	0.30
	1978 - 1992	T1	65	65	65	65	78	78	78	78	0.10
		T2	60	60	60	60	83	80	80	83	0.15
		T3	65	68	68	65	80	80	80	80	0.30
		T4	65	70	70	65	76	83	83	76	0.25
		T5	68	68	68	68	85	85	85	85	0.20
	1993 - 2001	T1	65	70	70	65	83	76	76	83	0.20
		T2	68	68	68	68	78	78	78	78	0.35
		T3	68	65	65	68	83	80	80	83	0.25
		T4	60	60	60	60	80	80	80	80	0.10
		T5	65	65	65	65	76	83	83	76	0.10
	2002 - 2005	T1	65	70	70	65	74	74	74	74	0.10
		T2	68	65	65	68	83	76	76	83	0.15
		T3	65	65	65	65	78	78	78	78	0.35
		T4	60	60	60	60	83	80	80	83	0.25
		T5	68	68	68	68	76	83	83	76	0.15
	After 2005	T1	65	70	70	65	74	74	74	74	0.35
		T2	68	68	68	68	83	76	76	83	0.20
		T3	60	60	60	60	78	78	78	78	0.25
		T4	68	65	65	68	83	80	80	83	0.10
		T5	70	65	65	70	80	80	80	80	0.10

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints				Cooling Temperature Setpoints				Thermostat Weight
			Morning	Day	Evening	Night	Morning	Day	Evening	Night	
CZ13	Before 1978	T1	68	68	68	68	76	83	83	76	0.10
		T2	65	65	65	65	80	83	83	80	0.20
		T3	70	65	65	70	83	83	83	83	0.10
		T4	60	60	60	60	85	85	85	85	0.30
		T5	65	70	70	65	90	90	90	90	0.30
	1978 - 1992	T1	65	70	70	65	80	80	80	80	0.20
		T2	70	70	70	70	76	83	83	76	0.10
		T3	68	65	65	68	83	83	83	83	0.20
		T4	68	68	68	68	85	85	85	85	0.30
		T5	70	65	65	70	90	90	90	90	0.20
	1993 - 2001	T1	65	70	70	65	83	76	76	83	0.10
		T2	68	65	65	68	78	78	78	78	0.15
		T3	70	65	65	70	83	80	80	83	0.25
		T4	70	70	70	70	80	80	80	80	0.25
		T5	72	72	72	72	76	83	83	76	0.25
	2002 - 2005	T1	70	70	70	70	83	76	76	83	0.10
		T2	65	70	70	65	78	78	78	78	0.20
		T3	68	68	68	68	83	80	80	83	0.30
		T4	68	65	65	68	80	80	80	80	0.25
		T5	60	60	60	60	76	83	83	76	0.15
	After 2005	T1	68	65	65	68	74	74	74	74	0.20
		T2	68	68	68	68	83	76	76	83	0.25
		T3	70	65	65	70	78	78	78	78	0.30
		T4	65	70	70	65	83	80	80	83	0.15
		T5	65	68	68	65	80	80	80	80	0.10
CZ14	Before 1978	T1	65	70	70	65	83	76	76	83	0.10
		T2	65	68	68	65	78	78	78	78	0.15
		T3	55	55	55	55	83	80	80	83	0.25
		T4	60	60	60	60	80	80	80	80	0.25
		T5	65	65	65	65	76	83	83	76	0.25
	1978 - 1992	T1	68	68	68	68	74	74	74	74	0.10
		T2	68	65	65	68	83	76	76	83	0.15
		T3	65	65	65	65	78	78	78	78	0.25
		T4	65	68	68	65	83	80	80	83	0.25
		T5	65	70	70	65	80	80	80	80	0.25
	1993 - 2001	T1	68	65	65	68	74	74	74	74	0.35
		T2	65	70	70	65	83	76	76	83	0.30
		T3	68	68	68	68	78	78	78	78	0.15
		T4	60	60	60	60	83	80	80	83	0.10
		T5	65	65	65	65	80	80	80	80	0.10
	2002 - 2005	T1	65	65	65	65	74	74	74	74	0.45
		T2	65	68	68	65	83	76	76	83	0.35
		T3	68	65	65	68	78	78	78	78	0.10
		T4	55	55	55	55	83	80	80	83	0.05
		T5	65	70	70	65	80	80	80	80	0.05
	After 2005	T1	65	70	70	65	74	74	74	74	0.45
		T2	65	68	68	65	83	76	76	83	0.35
		T3	70	65	65	70	78	78	78	78	0.10
		T4	60	60	60	60	83	80	80	83	0.05
		T5	65	65	65	65	80	80	80	80	0.05
CZ15	Before 1978	T1	55	55	55	55	83	80	80	83	0.10
		T2	65	65	65	65	80	83	83	80	0.10
		T3	68	68	68	68	83	83	83	83	0.10
		T4	68	65	65	68	85	85	85	85	0.30
		T5	65	70	70	65	90	90	90	90	0.40
	1978 - 1992	T1	68	65	65	68	83	80	80	83	0.10
		T2	68	68	68	68	80	83	83	80	0.10
		T3	70	65	65	70	83	83	83	83	0.10
		T4	70	70	70	70	85	85	85	85	0.30
		T5	72	72	72	72	90	90	90	90	0.40
	1993 - 2001	T1	68	65	65	68	83	76	76	83	0.10
		T2	68	68	68	68	78	78	78	78	0.20
		T3	70	65	65	70	83	80	80	83	0.20
		T4	70	70	70	70	80	80	80	80	0.25
		T5	72	72	72	72	85	85	85	85	0.25
	2002 - 2005	T1	68	65	65	68	78	78	78	78	0.05
		T2	68	68	68	68	83	80	80	83	0.10
		T3	70	65	65	70	80	80	80	80	0.20
		T4	70	70	70	70	76	83	83	76	0.20
		T5	72	72	72	72	85	85	85	85	0.45
	After 2005	T1	70	65	65	70	83	76	76	83	0.20
		T2	70	70	70	70	78	78	78	78	0.20
		T3	68	65	65	68	83	80	80	83	0.15
		T4	68	68	68	68	80	80	80	80	0.15
		T5	72	72	72	72	76	83	83	76	0.30

Climate Zone	Building Vintage	Tstat run	Heating Temperature Setpoints				Cooling Temperature Setpoints				Thermostat Weight
			Morning	Day	Evening	Night	Morning	Day	Evening	Night	
CZ16	Before 1978	T1	65	70	70	65	74	74	74	74	0.10
		T2	65	68	68	65	83	76	76	83	0.15
		T3	55	55	55	55	78	78	78	78	0.30
		T4	65	65	65	65	83	80	80	83	0.20
		T5	60	60	60	60	80	80	80	80	0.25
	1978 - 1992	T1	65	70	70	65	74	74	74	74	0.10
		T2	55	55	55	55	83	76	76	83	0.25
		T3	65	65	65	65	78	78	78	78	0.20
		T4	65	68	68	65	83	80	80	83	0.20
		T5	60	60	60	60	80	80	80	80	0.25
	1993 - 2001	T1	65	68	68	65	74	74	74	74	0.15
		T2	55	55	55	55	83	76	76	83	0.30
		T3	60	60	60	60	78	78	78	78	0.20
		T4	65	65	65	65	83	80	80	83	0.20
		T5	65	70	70	65	80	80	80	80	0.15
	2002 - 2005	T1	65	65	65	65	78	78	78	78	0.20
		T2	65	70	70	65	83	80	80	83	0.10
		T3	55	55	55	55	80	80	80	80	0.25
		T4	65	68	68	65	76	83	83	76	0.20
		T5	60	60	60	60	85	85	85	85	0.25
	After 2005	T1	60	60	60	60	83	76	76	83	0.20
		T2	65	70	70	65	78	78	78	78	0.15
		T3	55	55	55	55	80	80	80	80	0.25
		T4	65	65	65	65	76	83	83	76	0.20
		T5	65	68	68	65	85	85	85	85	0.20