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March 31, 2016

VIA ELECTRONIC DELIVERY

Honorable Kathleen H. Burgess
Secretary
New York State Public Service Commission
Three Empire State Plaza, 19th Floor
Albany, New York 12223-1350

RE: Case 14-M-0101 – Proceeding on Motion of the Commission in Regard to Reforming the Energy Vision

Case 15-M-0252 – In the Matter of Utility Energy Efficiency Programs

Matter 15-01319 – In the Matter of the New York State Technical Resource Manual

New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs – Residential, Multi-Family, and Commercial/Industrial Measures, Version 3

Measure Updates

Dear Secretary Burgess:

In accordance with the requirements set forth in the Order Adopting Regulatory Policy Framework and Implementation Plan issued by the Commission on February 26, 2015 in Case 14-M-0101, Niagara Mohawk Power Corporation d/b/a National Grid, The Brooklyn Union Gas Company d/b/a National Grid NY and KeySpan Gas East Corporation d/b/a National Grid (collectively "National Grid"), Central Hudson Gas and Electric Corporation, Consolidated Edison Company of New York, Inc., National Fuel Gas Distribution Corporation, New York State Electric & Gas Corporation, Orange and Rockland Utilities, Inc., and Rochester Gas and Electric Corporation (collectively the "Joint Utilities") assumed responsibility for maintaining the New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs– Residential, Multi-Family, and Commercial/Industrial Measures ("NY TRM") on June 1, 2015.

Pursuant to the Joint Utilities' Technical Resource Manual Management Plan filed with the Commission on June 1, 2015, a Technical Resource Manual Management Committee ("TRM MC") was established upon receipt of the NY TRM, Version 3, from the New York State Department of Public Service Staff.

The TRM MC has met regularly, and in the course of so doing, has reviewed and approved the two (2) measure updates attached hereto to Version 3 of the NY TRM to be effective March 31, 2016. It should be noted that if a measure or technology is included in or added to the NY TRM, it does not mean that such measure of technology is expressly supported or endorsed by the member companies of the TRM MC. In addition, it should be noted that there is no guarantee that measures or technologies included in the TRM will be offered by utility energy efficiency programs prospectively.

Respectfully submitted,

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New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs –

Residential, Multi-Family, and Commercial/Industrial Measures

Version 3

Issue Date – March 31, 2016
Effective Date – April 1, 2016

New York State Department of Public Service
Markets and Innovation, Office of Clean Energy
3 Empire State Plaza
Albany, New York 12223

Table of Revisions / Additions

Issue Date – March 31, 2016 Effective Date – April 1, 2016

Revisions and additions to the measures listed below were undertaken by the Joint Utilities (Technical Resource Manual) TRM Management Committee between January and March 2016. These revisions are to be incorporated into Version 3 of the *New York Standard Approach for Estimating Energy Savings from Energy Efficiency Programs–Residential, Multi-family, and Commercial/Industrial Measures effective April 1, 2016.*

R / A	Number	Measure	Description of Change	Location/Page in TRM Version 3
R	4-16-1	R/MF- HVAC- Heat Pump-Ground Source (GSHP)	Revised Ground Source Heat Pump for Single Family, Detached, Residential	N/A
R	4-16-2	C/I Appliance Recycling-Room Air Conditioner	Revision to minimum Compliance Efficiency tables	N/A

HEAT PUMP – GROUND SOURCE (GSHP)

Measure Description

A ground source heat pump system, with a closed loop heat exchanger field, which provides heating and cooling for space conditioning by the water to air transference of ground temperatures through a typical air-duct distribution system in a detached single-family residential home.

The GSHP analysis associated with this measure is based on several assumptions consistent with best practice design for a detached single-family residential building:

- ECCCNYS states systems shall be sized in accordance with ACCA Manual S based on building loads calculated in accordance with ACCA Manual J or other approved heating and cooling calculation methodologies[1].
- The building peak heating load in New York typically exceeds the peak cooling load, therefore the assumption that the GSHP runs at part-load during peak cooling hours.
- The ground loop heat exchanger is adequately sized and installed properly to allow the GSHP to meet the peak heating load without electric resistance auxiliary heat.
- The GSHP is equipped with either a two stage or variable speed compressor system, a variable speed or constant speed ground loop circulator pump, and a variable-speed blower distribution fan.
- The GSHP efficiency is rated in accordance with ISO-13256, and performance tables are provided by the manufacturer showing the efficiency and capacity of the unit under full and part load conditions.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings - Electric or ASHP heat baseline

$$\Delta kWh = units \times \left(ACL_{(btu/hr)} \times \frac{1}{1{,}000_{w/kw}} \times \left(\frac{1}{EER_{adj\ part\ baseline\ (btu/w\ -\ hr)}} - \frac{1}{EER_{adj\ part\ ee\ (btu/w\ -\ hr)}} \right) \times \left(EFLH_{cooling} \times F_{EFLH\ adj} \right) \right)$$

$$+ \left(AHL_{(btu/hr)} \times \frac{1}{1{,}000_{w/kw}} \times \left(\frac{1}{COP_{adj\ part\ baseline}} - \frac{1}{COP_{adj\ part\ ee}} \right) \times \frac{\left(EFLH_{heating} \times F_{EFLH\ adj} \right)}{3.412_{(btu/w\ -\ hr)}} \right)$$

Annual Electric Energy Savings – Fossil Fuel Heat Baseline

$$\Delta kWh = units \times \left(ACL_{(btu/hr)} \times \frac{1}{1{,}000_{w/kw}} \times \left(\frac{1}{EER_{adj\ part\ baseline\ (btu/w\ -\ hr)}} - \frac{1}{EER_{adj\ part\ ee\ (btu/w\ -\ hr)}} \right) \times \left(EFLH_{cooling} \times F_{EFLH\ adj} \right) \right)$$

$$- \left(AHL_{btu/hr} \times \frac{1}{1{,}000_{w/kw}} \times \frac{1}{COP_{adj\ part\ ee}} \times \frac{\left(EFLH_{heating} \times F_{EFLH\ adj} \right)}{3.412_{(btu/w\ -\ hr)}} \right)$$

Peak Coincident Demand Savings

$$\Delta kW = units \times ACL_{(btu/hr)} \times \frac{1}{1{,}000_{w/kw}} \times \left(\frac{1}{EER_{adj\ part\ baseline,\ (btu/w\ -\ hr)}} - \frac{1}{EER_{adj\ part\ ee,\ (btu/w\ -\ hr)}} \right) \times CF$$

[1] 2010 Energy Conservation Construction Code of New York State, Residential Energy Efficiency, Section 403.6 Equipment Sizing (Mandatory)

Annual Gas Energy Savings – Fossil Fuel Heat Baseline

$$\Delta\text{therms} = \text{units} \times \frac{\text{AHL}_{(\text{btu/hr})}}{100{,}000_{(\text{btu/therm})}} \times \left(\frac{1}{\text{AFUE}_{\text{baseline}} / 100} \right) \times \text{EFLH}_{\text{heating}} \times \text{F}_{\text{EFLH adj}}$$

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand savings
Δtherm	= Annual fossil fuel savings
units	= Number of units installed under the program
CF	= Coincidence Factor
EER_{part}	= Energy efficiency ratio (Btu/W-hour) at part-load
COP_{part}	= Coefficient of performance, ratio of output/input energy at part-load
AHL	= Actual heating load (Btu/hr) based on Manual J calculation
ACL	= Actual cooling load (Btu/hr) based on Manual J calculation
EFLH	= Equivalent full-load hours
$F_{EFLH\ adj}$	= Adjustment factor to account for oversizing assumption embedded in EFLH
AFUE	= Annual fuel utilization efficiency, seasonal energy efficiency for fuel heating equipment
100	= Conversion factor to convert AFUE to a decimal
1,000	= Conversion factor, one kW equals 1,000 Watts
3.412	= Conversion factor, one watt/h equals 3.412142 BTU
100,000	= Conversion factor, (BTU/therm), one therm equals 100,000 BTU's

Summary of Variables and Data Sources

Variable	Value	Notes
$AFUE_{baseline}$	Nameplate efficiency	Annual fuel utilization efficiency, seasonal energy efficiency for the minimally code compliant replacement space-heating equipment
$COP_{cooling}$		The ratio of heat removal to energy input to the compressor
$COP_{heating}$		The ratio of heat delivered to energy input to the compressor
COP_{adj}		Coefficient of performance from the manufactures' catalog data adjusted to account for applied fan and pump power.
EFLH		Effective Full Load Hours as presented in Appendix G
EER		Efficiency determined at a single rated condition specified by an appropriate equipment standard and is defined as the ratio of net cooling capacity - or heat removed in Btu/h - to the total input rate of electric power applied - in Watts. The units of EER are Btu/Wh.
EER_{adj}		Energy efficiency ratio from the manufactures' catalog data adjusted to account for applied fan and pump power.
$F_{EFLH\ adj}$	1.25	Adjustment factor to EFLH to account for oversizing assumption embedded in EFLH data presented in the Appendix G. (see Operating Hours below)

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8

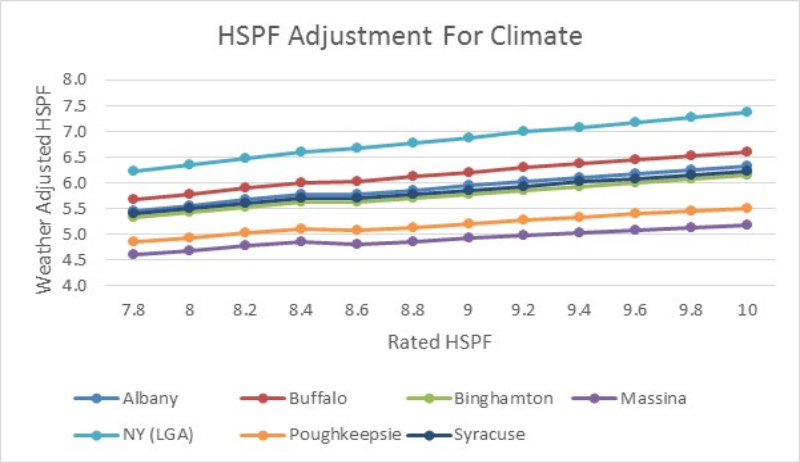
Baseline Efficiencies from Which Savings are Calculated

The baseline efficiency used for a GSHP is the efficiency level of the minimally code compliant replacement equipment for the existing heating and cooling systems. The minimally code compliant efficiency level shall comply with the requirements of the current state code, or under state law, an equal or more stringent code or standard adopted by the municipality or jurisdiction applicable to the installation site.

For example, the baseline efficiency level for a GSHP with existing equipment in a normal/end-of-life replacement scenario would be: 1) For the space-cooling component, a central air conditioner with a SEER of 13 or an air-source heat pump with a SEER of 14; 2) For the space-heating component, with an existing natural gas furnace, an equivalent baseline efficiency, stated as the Annual Fuel Utilization Efficiency (AFUE), would be 80%. Note, the baseline efficiency for electric resistance heat would have a COP of 1.0.

Air source heat pumps are rated under a standard set of conditions. For cooling, the differences between the rated conditions and those in New York are small, however for heating, the differences between the rated conditions and those experienced in New York are significant. To account for these differences during the heating season, a climate-adjustment factor, as defined in the table below, must be used to define the project baseline when that baseline is an air source heat pump.

The HSPF is the AHRI rated heating seasonal average efficiency expressed in terms of Btu/hr-watt. A seasonal average adjusted COP of an air-source heat pump is used in the above equations. This adjusted COP equals the adjusted heating season HSPF divided by 3.412, where the adjusted HSPF is calculated by multiplying the rated HSPF by the appropriate HSPF climate adjustment factor below.



HSPF Climate Adjustment Factor[2]

City	HSPF < 8.5	HSPF ≥ 8.5
Albany	0.70	0.67
Buffalo	0.73	0.70
Binghamton	0.68	0.65
Massena	0.59	0.56
NY (LGA)	0.80	0.78
Poughkeepsie	0.62	0.59
Syracuse	0.69	0.66

[2] HSPF climate adjustment factors were calculated using the method outlined in reference #4 and the winter design temperatures from the TMY3 weather data for the cities indicated in the Table.

Compliance Efficiency from which Incentives are Calculated

Ground source heat pumps are rated according to ISO-13256. The efficiency specifications in ISO-13256 account for the compressor energy and supply fan, and pump energy required to overcome air and fluid pressure drop internal to the unit. The analysis is based on the actual building heating and cooling loads from a Manual J calculation, rather than the installed equipment nameplate capacity. Thus, the analysis uses an adjustment factor to remove the embedded oversizing assumptions in the Appendix G EFLH data. The ISO-13256 efficiency rating procedure addresses the efficiency of the GSHP only, not the entire system. The fan energy required distribute air through the duct system and the pump energy required to move the heat transfer fluid through the ground loop is accounted for separately in this analysis.

The seasonal average cooling and heating efficiencies are estimated from the manufacturers' catalog EER and COP data at the cooling and heating seasonal average entering fluid temperature and capacity. EER and COP ratings provided in manufacturers' catalogs were developed under conditions specified in ISO 13256, which do not include fan and pump power external to the unit. An adjustment factor is applied to the manufacturers' catalog data to account for fan and pump power:

$$EER_{adj} = (\text{EER at } GWT_{cooling}) \times F_{cooling}$$

$$COP_{adj} = (\text{COP at } GWT_{heating}) \times F_{heating}$$

Summary of Variables and Data Sources

Variable	Value	Source
$GWT_{cooling}$	60 °F	Heat pump entering water temperature. Data source; monitored ground loop temperature data from geothermal heat pump systems installed in NY (see reference 6). The data was recorded on a daily basis over a 12-month period, including a full cooling season.
$GWT_{heating}$	40 °F	Heat pump entering water temperature. Data source; monitored ground loop temperature data from geothermal heat pump systems installed in NY (see reference 6). The data was recorded on a daily basis over a 12-month period, including a full heating season.
$F_{cooling}$		Adjustment factor to the manufacturers' catalog data is applied to account for fan and pump power consumption during cooling mode
$F_{heating}$		Adjustment factor to the manufacturers' catalog data is applied to account for fan and pump power consumption during heating mode

Data concerning the external static pressure (ESP) imposed on the unit during ISO testing are not generally available. It is assumed that the ESP during the test is representative of the ESP of a typical duct system. Pump power for a well-designed system from the ASHRAE Geothermal Heating and Cooling System Design Guide is shown below:

Installed Pump Power	Power into Pump Motor	Grade	Available Head with 70% Efficient Pump at 3gpm/ton
<5hp/100 tons	< 45 W/ton	A	< 46 ft. of water

The EER and COP ratings provided in manufacturers' catalogs were developed under conditions specified in ISO 13256, which do not include fan and pump power external to the unit. An adjustment factor to the manufacturers' catalog data as a function of external pumping power are shown below for variable-speed and constant two-speed ground-water pumping systems:

Unit Type	Stage	Pump power (W/ton)	Unit Type	$F_{cooling}$	$F_{heating}$
Variable	Low	45	Variable flow	0.85	0.93
Two-stage	Low	45	Variable flow	0.84	0.91
Variable	Low	45	Constant flow	0.75	0.86
Two-Stage	Low	45	Constant flow	0.80	0.88

Operating Hours

Operating hours are based on EFLH as presented in Appendix G. Note, the EFLH data in Appendix G are based on system nameplate capacity, while the equations in this section are based on actual building load. The $F_{EFLH\ adj}$ factor is introduced to account for the equipment oversizing assumption embedded in the Appendix G data. The oversizing assumption embedded in the Appendix G data are appropriate for equipment sized to meet the peak-cooling load, such as central air conditioners and air source heat pumps. However, GSHPs are typically sized to meet the heating load; and the oversizing assumptions embedded in the Appendix G data are not appropriate.

Effective Useful Life (EUL)

Years: 20[3]

Source: US DOE

Ancillary Fossil Fuel Savings Impacts

Anticipate further review of ancillary fossil fuel impacts.

Ancillary Electric Savings Impacts

Anticipate further review of ancillary electric savings impacts

References

1. Kavanaugh, S and Rafferty, K (2015) *Geothermal Heating and Cooling, Design of Ground-Source Heat Pump Systems* RP-1674, Atlanta, GA. ASHRAE Inc.
2. *Energy Conservation Construction Code of New York State* (ECCCNYS)
3. *New York City Energy Conservation Code* (NYCECC)
4. Fairey, P., D. Parker, B Wilcox, M Lombardi. *Climate Impacts on Heating Seasonal Performance Factor (HSPF) and Seasonal Energy Efficiency Ratio (SEER) for Air Source Heat Pumps,* ASHRAE Transactions, 110(2): 178-88.
5. *Water Source Heat Pumps – Testing and Rating for Performance – Part 1: Water to Air and Brine to Air Heat Pumps* (2012) Arlington, VA. ANSI/ASHRAE/ISO Standard 13256-1:1998 (RA 2012), AHRI, 2012.
6. *Manual J Residential Load Calculation*, Arlington, VA. Air Conditioning Contractors Association,
7. *Guide to Geothermal Heat Pumps* (February 2011) U. S. Department of Energy, Energy Efficiency and Renewable Energy, DOE/EE-0385
8. Monitored data from geothermal heat pump systems installed in New York State submitted August 2015 by the New York Geothermal Energy Organization, and reviewed by NYS DPS Staff.

Record of Revision

Record of Revision Number	Issue Date
1	10/15/2010
4-16-1	2/17/2016

[3] *Guide to Geothermal Heat Pumps*, U. S. Department of Energy, Energy Efficiency and Renewable Energy, DOE/EE-0385, February2011.

APPLIANCE RECYCLING

AIR CONDITIONER – ROOM (WINDOW) AIR CONDITIONER RECYCLING

Measure Description

Room (Window) Air Conditioners, a consumer (appliance) product, other than a "packaged terminal air conditioner," which is powered by a single-phase electric current and is an encased assembly designed as a unit for mounting in a window or through the wall for the purpose of providing delivery of conditioned air to an enclosed space. It includes a prime source of refrigeration and may include a means for ventilating and heating.[4] Minimum energy conservation standards for these appliances have been established by the Code for Federal Regulations 10 CFR 430.32(b). As this standard continues to be revised, and by association Energy Star standards continue to increase, operational savings attributable to new RAC may justify early retirement before the full useful life has been exhausted. In order to realize the anticipated savings, a currently functioning appliance of equivalent cooling capacity and type having been manufactured before June 2014 must be properly disposed of when a new appliance is supplied to the customer.

Method for Calculating Annual Energy and Peak Coincident Demand Savings

Annual Electric Energy Savings, Method using EER

$$\Delta\text{kWh} = \frac{\text{Capacity}}{1{,}000} \times \left(\frac{1}{\text{EER}_{\text{base}}} - \frac{1}{\text{EER}_{\text{ee}}}\right) \times \text{EFLH}_{\text{cooling}}$$

Annual Electric Energy Savings, Alternate Method using CEER[2]

$$\Delta\text{kWh} = \frac{\text{Capacity}}{1{,}000} \times \left(\frac{1}{\text{CEER}_{\text{base}}} - \frac{1}{\text{CEER}_{\text{ee}}}\right) \times \text{EFLH}_{\text{cooling}}$$

Peak Coincident Demand Savings, Method using EER

$$\Delta\text{kW} = \frac{\text{Capacity}}{1{,}000} \times \left(\frac{1}{\text{EER}_{\text{base}}} - \frac{1}{\text{EER}_{\text{ee}}}\right) \times \text{CF}$$

Peak Coincident Demand Savings, Alternate Method using CEER[2]

$$\Delta kW = \frac{Capacity}{1{,}000} \times \left(\frac{1}{CEER_{base}} - \frac{1}{CEER_{ee}}\right) \times CF$$

Annual Gas Energy Savings

Δtherms = N/A

where:

ΔkWh	= Annual electric energy savings
ΔkW	= Peak coincident demand electric savings
Δtherms	= Annual gas energy savings
Capacity	= Cooling output rating, in BTU/hr
$\text{EFLH}_{\text{cooling}}$	= Cooling Equivalent Full-Load Hours
CF	= Coincidence Factor

[4] Energy Star® Program Requirements, Product Specification for Room Air Conditioners, Eligibility Criteria Version 3.1

[2] When available the Combined Energy Efficiency Ratio should be used for the purpose of calculating annual electrical energy savings.

CEER = Combined Energy Efficiency Ratio
EER = Energy Efficiency Ratio
ee = Energy efficient condition or measure
baseline = Baseline condition or measure
1,000 = Conversion factor (1,000 Watts / Kilowatt)

Packaged Terminal Air Conditioner (PTAC) is defined as a wall sleeve and a separate unencased combination of heating and cooling assemblies specified by the builder and intended for mounting through the wall.

RAC with louvered sides have exterior side vents to facilitate airflow over the outdoor coil.

RAC with reverse cycle are appliances that may reverse the refrigeration cycle so as to serve as heating equipment, also known as a heat pump.

Summary of Variables and Data Sources

Variable	Value	Notes
Capacity		From application.
$EFLH_{cooling}$		Cooling equivalent full-load hours by building type, Appendix G.
$CEER_{baseline}$		From application, or lookup from table below based on unit capacity when unknown.
$CEER_{ee}$		From application.
$EER_{baseline}$		From application, or lookup from table below based on unit capacity when unknown.
EER_{ee}		From application.

Coincidence Factor (CF)

The recommended value for the coincidence factor is 0.8

Baseline Efficiencies from which Savings are Calculated

Baseline efficiency assumptions for normal replacement of units manufactured between the years 2000 - 2014. Baseline efficiency of air conditioners manufactured after June 2014 will be the compliance efficiency.

Room Air Conditioners

Capacity (BTU/hr)	with Louvered Sides (EER_{base})	without Louvered Sides (EER_{base})
< 6,000	≥ 9.7	≥ 9.0
6,000 - 8,000	≥ 9.7	≥ 9.0
8,000 – 13,999	≥ 9.8	≥ 8.5
14,000 – 19,999	≥ 9.7	≥ 8.5
20,000– 24,999	≥ 8.5	≥ 8.5
≥ 25,000	≥ 8.5	≥ 8.5

Room Air Conditioners - Casement

Capacity (BTU/hr)	Casement Only (EER_{base})	Casement - Slider (EER_{base})
All	≥ 8.7	≥ 9.5

Room (Air Conditioners with Reverse Cycle) Heat Pumps

Capacity (BTU/hr)	with Louvered Sides (EER_{base})	without Louvered Sides (EER_{base})
< 6,000	≥ 9.0	≥ 8.5
6,000 - 8,000	≥ 9.0	≥ 8.5
8,000 – 13,999	≥ 9.0	≥ 8.5
14,000 – 19,999	≥ 9.0	≥ 8.0
≥ 20,000	≥ 8.5	≥ 8.0

Compliance Efficiency from which Incentives are Calculated

Units will be treated as early retirement and total lifetime energy savings will be calculated based on remaining years of useful life (RUL) of the existing baseline unit. Units greater than 15 years old will be considered normal replacements and will be given incremental savings. Incremental savings are defined as the difference between the annual kWh consumption of minimally compliant with Federal appliance standards and the annual kWh consumption of the new unit.

Room Air Conditioners

Capacity (BTU/hr)	with Louvered Sides (EER_{ee})	without Louvered Sides (EER_{ee})
< 6,000	≥ 11.0	≥ 10.0
6,000 - 8,000	≥ 11.0	≥ 10.0
8,000 – 13,999	≥ 10.9	≥ 9.6
14,000 – 19,999	≥ 10.7	≥ 9.5
20,000– 24,999	≥ 9.4	≥ 9.3
≥ 25,000	≥ 9.0	≥ 9.4

Room Air Conditioners - Casement

Capacity (BTU/hr)	Casement Only (EER_{ee})	Casement - Slider (EER_{ee})
All	≥ 9.5	≥ 10.4

Room (Air Conditioners with Reverse Cycle) Heat Pumps

Capacity (BTU/hr)	with Louvered Sides (EER_{ee})	without Louvered Sides (EER_{ee})
< 6,000	≥ 9.8	≥ 9.3
6,000 - 8,000	≥ 9.8	≥ 9.3
8,000 – 13,999	≥ 9.8	≥ 9.3
14,000 – 19,999	≥ 9.8	≥ 8.7
≥ 20,000– 24,999	≥ 9.3	≥ 8.7

Operating Hours

Reference Appendix G for applicable value for specific building use type and geographic location.

Effective Useful Life (EUL)

Years: 15
Source: 2005 DEER

Remaining Useful Life (RUL)

RUL = 15 year – (2014 – Year Manufactured)

Ancillary Fossil Fuel Savings Impacts

Ancillary Electric Savings Impacts

References

1. EFLH taken from Coincidence Factor Study Residential Room Air Conditioners, conducted by RLW Analytics, 2008.
    a. neep.org/.../2008-6-23_Final_Report_Coincidence_Factor_Study_Residential _Room_Air_Conditioners_SPWG.pdf
2. Replacement factor taken from the Nexus Market Research. December 2005. Impact Process and Market Study of the Connecticut Appliance Retirement Program: Overall Report. Cambridge, Mass.: Nexus Market

Record of Revision

Record of Revision Number	Issue Date
1-16-15	1/1/2016
4-16-2	3/31/2016