4.4.9 Heat Pump Systems

**Description**

This measure applies to the installation of high-efficiency air cooled, water source, ground water source, and ground source heat pump systems. This measure could apply to replacing an existing unit at the end of its useful life, or installation of a new unit in a new or existing building.

This measure was developed to be applicable to the following program types: TOS NC. If applied to other program types, the measure savings should be verified.

**Definition of Efficient Equipment**

In order for this characterization to apply, the efficient equipment is assumed to be a high-efficiency air cooled, water source, ground water source, or ground source heat pump system that exceeds the energy efficiency requirements of the 2012 or 2015 International Energy Conservation Code (IECC), depending on the IECC in effect on the date of the building permit.

**Definition of Baseline Equipment**

In order for this characterization to apply, the baseline equipment is assumed to be a standard-efficiency air cooled, water source, ground water source, or ground source heat pump system that meets the energy efficiency requirements of the 2012 or 2015 IECC, depending on the IECC in effect on the date of the building permit. The rating conditions for the baseline and efficient equipment efficiencies must be equivalent.

**Deemed Lifetime of Efficient Equipment**

The expected measure life is assumed to be 15 years.[[1]](#footnote-1)

**Deemed Measure Cost**

For analysis purposes, the incremental capital cost for this measure is assumed as $100 per ton for air-cooled units.[[2]](#footnote-2) The incremental cost for all other equipment types should be determined on a site-specific basis.

**Loadshape**

Loadshape C05 - Commercial Electric Heating and Cooling

**Coincidence Factor**

The summer peak coincidence factor for cooling is provided in two different ways below. The first is used to estimate peak savings during the utility peak hour and is most indicative of actual peak benefits, and the second represents the *average* savings over the defined summer peak period, and is presented so that savings can be bid into PJM’s Forward Capacity Market.  Both values provided are based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren.

CFSSP = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

= 91.3% [[3]](#footnote-3)

CFPJM = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

= 47.8% [[4]](#footnote-4)

**Algorithm**

**Calculation of Savings**

**Electric Energy Savings**

For units with cooling capacities less than 65 kBtu/hr:

ΔkWh= Annual kWh Savingscool + Annual kWh Savingsheat

Annual kWh Savingscool = (kBtu/hrcool) \* [(1/SEERbase) – (1/SEERee)] \* EFLHcool

Annual kWh Savingsheat = (kBtu/hrcool) \* [(1/HSPFbase) – (1/HSPFee)] \* EFLHheat

For units with cooling capacities equal to or greater than 65 kBtu/hr:

ΔkWh= Annual kWh Savingscool + Annual kWh Savingsheat

Annual kWh Savingscool = (kBtu/hrcool) \* [(1/EERbase) – (1/EERee)] \* EFLHcool

Annual kWh Savingsheat = (kBtu/hrheat)/3.412 \* [(1/COPbase) – (1/COPee)] \* EFLHheat

Where:

kBtu/hrcool = capacity of the cooling equipment in kBtu per hour (1 ton of cooling capacity equals 12 kBtu/hr).

= Actual installed

SEERbase =Seasonal Energy Efficiency Ratio of the baseline equipment

= SEER from tables below, based on the applicable IECC on the date of the building permit

SEERee = Seasonal Energy Efficiency Ratio of the energy efficient equipment.

= Actual installed

EFLHcool = Equivalent Full Load Hours for cooling are provided in section 4.4 HVAC End Use.

HSPFbase = Heating Seasonal Performance Factor of the baseline equipment

= HSPF from tables below, based on the applicable IECC on the date of the building permit

HSPFee = Heating Seasonal Performance Factor of the energy efficient equipment.

= Actual installed

EFLHheat  = heating mode equivalent full load hours are provided in section 4.4 HVAC End Use.

EERbase = Energy Efficiency Ratio of the baseline equipment

= EER from tables below, based on the applicable IECC on the date of the building permit. For air-cooled units < 65 kBtu/hr, assume the following conversion from SEER to EER for calculation of peak savings:[[5]](#footnote-5)

EER = (-0.02 \* SEER2) + (1.12 \* SEER)

EERee = Energy Efficiency Ratio of the energy efficient equipment. For air-cooled units < 65 kBtu/hr, if the actual EERee is unknown, assume the conversion from SEER to EER as provided above.

= Actual installed

kBtu/hrheat = capacity of the heating equipment in kBtu per hour.

= Actual installed

3.412 = Btu per Wh.

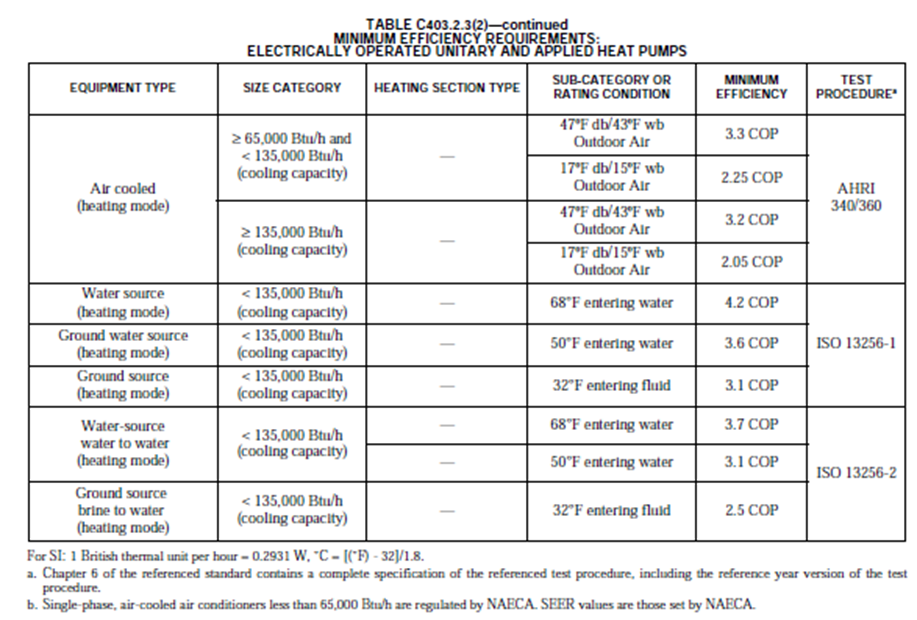
COPbase = coefficient of performance of the baseline equipment

= COP from tables below, based on the applicable IECC on the date of the building permit.

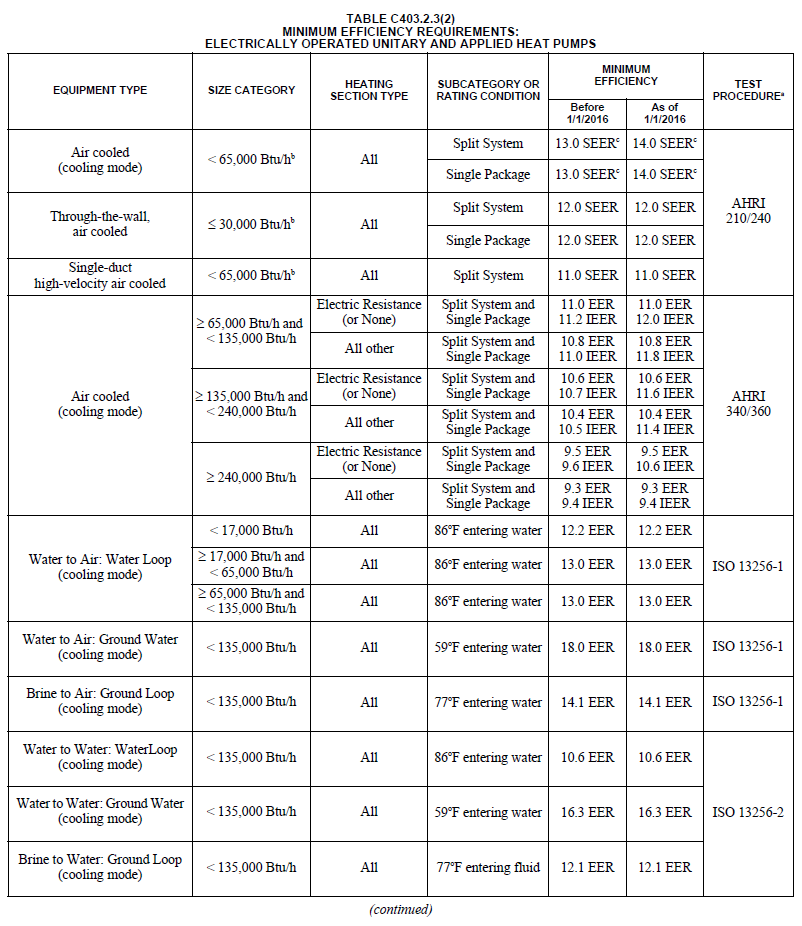
COPee = coefficient of performance of the energy efficient equipment.

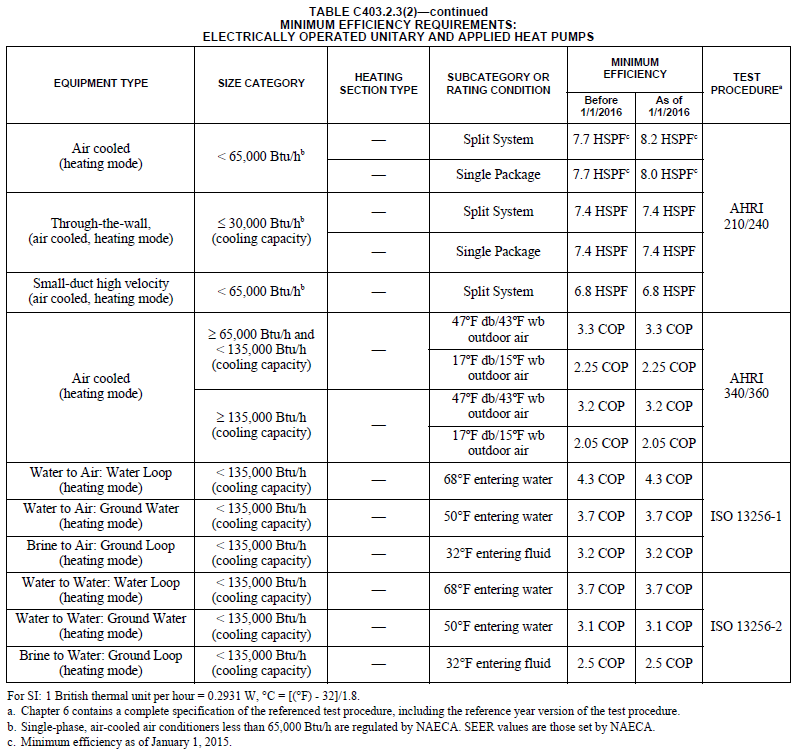
= Actual installed

Minimum Efficiency Requirements: 2012 IECC



Minimum Efficiency Requirements: 2015 IECC





For example a 5 ton cooling unit with 60 kbtu heating, an efficient EER of 14, and an efficient HSPF of 9, at a restaurant in Chicago with a building permit dated before 1/1/2016 saves:

= [(60) \* [(1/13) – (1/14)] \* 1134] + [(60) \* [(1/7.7) – (1/9)] \* 1354]

= 1650 kWh

**Summer Coincident Peak Demand Savings**

ΔkW = (kBtu/hrcool) \* [(1/EERbase) – (1/EERee)] \*CF

Where CF value is chosen between:

CFSSP = Summer System Peak Coincidence Factor for Commercial cooling (during system peak hour)

= 91.3% [[6]](#footnote-7)

CFPJM = PJM Summer Peak Coincidence Factor for Commercial cooling (average during peak period)

= 47.8% [[7]](#footnote-8)

For example a 5 ton cooling unit with 60 kbtu heating, an efficient EER of 14, and an efficient HSPF of 9 saves:

ΔkW = [(60) \* [(1/13) – (1/14)] \*.913

= 0.3

**Natural Gas Energy Savings**

N/A

**Water Impact Descriptions and Calculation**

N/A

**Deemed O&M Cost Adjustment Calculation**

N/A

**Measure Code: CI-HVC-HPSY-V04-160601**

1. Measure Life Report: Residential and Commercial/Industrial Lighting and HVAC Measures, GDS Associates, Inc., June 2007. [↑](#footnote-ref-1)
2. Based on a review of TRM incremental cost assumptions from Vermont, Wisconsin, and California. [↑](#footnote-ref-2)
3. Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility’s peak hour is divided by the maximum AC load during the year. [↑](#footnote-ref-3)
4. Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year [↑](#footnote-ref-4)
5. Based on Wassmer, M. (2003). A Component-Based Model for Residential Air Conditioner and Heat Pump Energy Calculations. Masters Thesis, University of Colorado at Boulder. Note this is appropriate for single speed units only. [↑](#footnote-ref-5)
6. Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The AC load during the utility’s peak hour is divided by the maximum AC load during the year. [↑](#footnote-ref-7)
7. Based on analysis of Itron eShape data for Missouri, calibrated to Illinois loads, supplied by Ameren. The average AC load over the PJM peak period (1-5pm, M-F, June through August) is divided by the maximum AC load during the year [↑](#footnote-ref-8)