



ENERGY STAR[®] Program Requirements Product Specification for Automatic Commercial Ice Makers

Eligibility Criteria DRAFT 2: Version 2.0

Following is the **DRAFT 2 Version 2.0** product specification for ENERGY STAR qualified Automatic Commercial Ice Makers. A product shall meet all of the identified criteria if it is to earn the ENERGY STAR.

1) Definitions: Provided below are definitions of the relevant terms in this document.

- A. Automatic Commercial Ice Maker: A factory-made assembly (not necessarily shipped in one package) consisting of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice. It is an assembly that makes up to 4,000 lbs of ice per day, and may also include means for storing or dispensing ice, or both.
- B. Air-Cooled: An ice maker wherein motor driven fans or centrifugal blowers move air through the condenser to remove heat from the refrigerant.
- C. Water-Cooled: An ice maker that utilizes water running through the condenser to remove heat from the refrigerant.
- D. Batch-Type Ice Maker: An ice maker having alternate freezing and harvesting periods. This includes automatic commercial ice makers that produce cube type ice, tube type automatic commercial ice makers, and other batch technologies. Also referred to as cube type ice maker in AHRI Standard 810-2007. AHRI Standard 810-2007's definition clarifies that "cube" does not reference a specific size or shape and includes all automatic commercial ice makers with alternate freezing and harvesting periods.
- E. Continuous-Type Ice Maker: An ice maker that continually freezes and harvests ice at the same time. The following ice types are produced by continuous machines:
 - a) Flake: typically used for cooling food, commercial and industrial process cooling, and special medical and scientific cooling applications.
 - b) Nugget: typically used for cooling water and beverage drinks, and for a chewable ice with a softer consistency than cube ice.

Note: EPA received feedback that the flake and nugget definitions presented in the Draft 1 proposal, which distinguished nugget and flake machines based on the presence of an ice compression feature was inaccurate. Stakeholders clarified that both system types may utilize compression but to differing degrees, which is difficult to quantify.

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) Engineering Committee of Automatic Commercial Ice-Makers (ACIM), is developing flake and nugget definitions, which EPA included in Draft 2 for informational purposes only. The binning for purposes of qualification will be based on continuous vs. batch design. EPA continues to align with the proposed definition for Continuous Type ice makers in the ACIM Test Procedure (TP) Notice of Proposed Rulemaking (NOPR). Stakeholders are encouraged to comment on these new definitions.

Ice Machine Categories

- F. Ice Making Head (IMH): A model with the ice-making mechanism and the condensing unit in a single package, but with a separate ice storage bin .
- G. Remote Condensing Unit (RCU) or Split System Unit: A model in which the ice-making mechanism and condenser or condensing unit are in separate sections. This includes ice makers with and without remote compressor.
- H. Self-Contained Unit (SCU): A model in which the ice-making mechanism and storage compartment are in an integral cabinet.

Note: EPA continues to propose using the IMH, RCU, and SCU classifications in regards to binning products for evaluation and qualification. Industry representatives have continued to suggest that purchases are driven first by space, footprint, harvest rate, and application including desired ice type. This would support binning based on batch and continuous technologies as well as IMH, RCU, and SCU, all of which have installation and potential cost considerations. EPA continues to believe that the varied applications and purchasing behaviors justify maintaining their separation in this specification and incentivizes innovation while ensuring sufficient consumer choice. EPA welcomes comments on this approach and these assumptions about purchasing behavior.

Metric Definitions

- I. Energy Consumption Rate: Total energy input rate, stated in kWh/100 lb [kWh/45.0 kg] of ice, stated in multiples of 0.1. For RCU systems, energy consumption rate shall include condenser fan energy.
- J. Ice Harvest Rate: The gross weight of ice harvested, stated in lb/24 h [kg/24 h], stated in multiples of 1.
- K. Ice Hardness Factor: For Continuous Type Ice-Makers only, the ice hardness factor is the latent heat capacity of ice harvested, Btu/lb [W/kg], as defined in ASHRAE Standard 29, Table A1, line 15, divided by 144 Btu/lb [92.9 W/kg], multiplied by 100, %.
- L. Calorimeter Constant: The inverse of the ice hardness factor expressed as a decimal. The calorimeter constant is the ratio of the latent heat of fully frozen ice and the latent heat capacity of the ice harvested (a mix of frozen and liquid water) of the same weight.

- M. Potable Water Use: The amount of potable water used in making ice, which is equal to the sum of the ice harvested, Dump or Purge Water, and the Harvest Water expressed in gal/100 lb [L/45.0 kg] of ice, stated in multiples of 0.1. Alternatively, the amount of water entering the icemaker per cycle can be measured.
- N. Dump or Purge Water. The water from the ice making process that is not frozen at the end of the freeze cycle and is discharged from a batch and continuous type Automatic Commercial Ice-Maker.
- O. Harvest Water: The water that has been collected with the ice used to measure the machine's capacity.
- P. Basic Model: All units of a given type manufactured by one manufacturer, having the same primary energy source, and which have essentially identical electrical, physical, and functional (or hydraulic) characteristics that affect energy consumption, energy efficiency, water consumption, or water efficiency.

Note: For purposes of harmonization, EPA will adopt the DOE ACIM Test Procedure definitions upon publication of the final test procedure.

2) Scope:

- A. Included Products: Products that meet the definition of an Automatic Commercial Ice Maker as specified herein are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.B. Air-cooled batch and continuous type, IMH, RCU, and SCU designs can qualify for ENERGY STAR.
- B. Excluded Products: Water cooled ice makers and RCU machines designed for connection to remote compressor racks are not eligible for ENERGY STAR.

Note: EPA received feedback during the May ENERGY STAR stakeholder meeting supporting the exclusion of RCU units designed for connection to remote rack compressors until a workable solution can be reached to address compressor energy use. The DOE Test Procedure (TP) NOPR (Notice of Proposed Rule Making) proposes requiring that a dedicated compressor be assigned to the RCU for testing, such that the energy used by the compressor is accounted for in the rating (76 FR 18428, 18433). Further guidance regarding these product types will be provided by DOE in their final test procedure rule making. EPA intends to align with the DOE approach once finalized and will update the specification, as appropriate.

During the meeting, several manufacturers also requested that EPA consider adding Ice and Water Dispensers to the scope of the specification. EPA is considering excluding these product types due to concern regarding the energy consumption of the water dispensing function, which is not currently measured or reported. To date, EPA has received supporting data from only one manufacturer suggesting a 1-1.5% energy contribution from water dispensing. EPA is seeking additional data that represents several manufacturers, including information as to whether other active components are included in standard product designs (i.e. chillers, pumps, etc.). At this advanced stage in the draft development process, unless a significant amount of data is received by early September 2011, EPA will decide to exclude Ice and Water dispensers from Version 2.0 and address them in the next Version of the specification.

3) Qualification Criteria:

A. The qualification criteria is applied in the following steps:

1. Determine the Energy Consumption Rate and Potable Water Use of the product by performing the test method specified in Section 4.
2. For Continuous Type Ice Makers only, adjust the Energy Consumption Rate for ice hardness by multiplying it by the Ice Hardness Adjustment Factor provided here, where the Calorimeter Constant is measured using the test method in Section 4.

$$\text{Ice Hardness Adjustment Factor} = \left[\frac{144 \text{ Btu/lb} + 38 \text{ Btu/lb}}{\left(\frac{144 \text{ Btu/lb}}{\text{calorimeter constant}} \right) + 38 \text{ Btu/lb}} \right]$$

Compare the adjusted Energy Consumption Rate and the measured Potable Water Use values to the ENERGY STAR minimum values presented in Table 2, below.

3. For Batch Type systems, compare the measured Energy Consumption Rate and measured Potable Water Use values to the requirement values in Table 1, below.

Note: In general, stakeholders support the use of the Ice Quality Adjustment Factor proposed by the DOE TP NOPR that recognizes the direct relationship between ice quality and energy consumption. This adjustment factor seeks to normalize the ice harvest rate for purposes of comparing continuous type systems that produce a wide array of hardness levels. An adjustment factor also addresses concerns that an end user may choose what appears to be a more energy-efficient machine without also understanding that the resulting ice product may be softer.

EPA also found that a majority of stakeholders support the use of the term ice “hardness” rather than ice “quality” to describe frozen water content. Industry perception is that “quality” implies value and may misinform consumers, whereas “hardness” is a neutral term that more accurately describes the resulting property and “feel” of the ice product to the consumer. As such, EPA proposes using the term ice “hardness” in this Version 2.0 specification. Stakeholders are encouraged to provide feedback on this terminology.

One stakeholder commented that the ice hardness adjustment factor should also be applied to batch ice makers because batch ice is technically not at 100% ice hardness. The concern stems from the fact that while most nugget systems produce ice at hardness levels of 75-85%, there are nugget systems that make harder ice. These machines directly compete with batch systems and may be unfairly disadvantaged by the Ice Hardness Adjustment factor if only applied to Continuous-type systems. Based on additional outreach, most manufacturers indicated that batch ice is 100% hard within 1-5%. However, EPA has no data on batch ice hardness at this time. One stakeholder suggested that EPA post both the adjusted and non-adjusted energy use values for continuous systems allowing consumers to compare non-adjusted values amongst nugget and batch products, if needed. Stakeholders are encouraged to provide suggestions on how EPA can provide for a level playing field within the current binning structure where there is overlap.

- B. **Energy Consumption Rate:** The Energy Consumption Rate requirement is a function of harvest rate in the form of $L = A * H^a - b$, where L is the energy consumption rate requirement level, H is the ice harvest rate for the system under evaluation, A is a coefficient, a is an exponent, and b is a constant.

Table 1: ENERGY STAR Requirements for Air-Cooled Batch Type Ice Makers		
Equipment Type	Energy Consumption Rate (kWh/100 lbs ice)	Potable Water Use (gal/100 lbs ice)
IMH	$\leq 24.94 * H^{-0.234} - 0.15$	≤ 20.0
RCU	$\leq 29.67 * H^{-0.258} - 0.14$	≤ 20.0
SCU	$\leq 48.66 * H^{-0.326} + 0.08$	≤ 25.0

Table 2: ENERGY STAR Requirements for Air-Cooled Continuous Type Ice Makers		
Equipment Type	Energy Consumption Rate (kWh/100 lbs ice)	Potable Water Use (gal/100 lbs ice)
IMH	$\leq 18.74 * H^{-0.164} - 0.40$	≤ 15.0
RCU	$\leq 6.00 * H^{0.162} + 3.50$	≤ 15.0
SCU	$\leq 59.45 * H^{-0.349} - 0.10$	≤ 15.0

Note: For Continuous-type ice makers, EPA proposes the following changes: (1) the adjustment factor proposed by the DOE TP NOPR is applied to normalize for ice hardness, and (2) one continuous type category is defined rather than separating products into nugget and flake sub-groups. EPA has compiled a robust ice hardness data set representing a majority of available Continuous Type products that supports these changes. The adjustment factor produces more comparable flake and nugget values, and appears to be fair and reliable. EPA asks that stakeholders provide comments as to whether the resulting adjusted values appear reasonable based on manufacturers' knowledge of their product offerings. Also, EPA found that the adjusted energy data continues to follow a power curve relationship with the ice harvest rate and therefore, proposes similar power curve level lines for continuous ice makers.

There was some concern that although the power curve approach proposed in Draft 1 was technically viable, ENERGY STAR systems weren't being represented across the range of system capacities. Previously in Draft 1, the curve fit approach was performed for the larger batch and continuous system data sets, resulting in 2 overall curves that were then offset for each equipment type (IMH, RCU, and SCU) to achieve desired ENERGY STAR levels. This was due to small flake and nugget data sets within the equipment types at the time of the Draft 1 release. For the Draft 2, EPA is working with a larger data set, which now combines flake and nugget machines. To improve consumer choice across the buying categories they make use of, EPA proposes to derive specification levels using a curve fit for each equipment type data set (IMH, RCU, and SCU) for Batch and Continuous, resulting in 6 curves. EPA found it necessary to adjust the RCU Continuous ice maker level curve fit equation by changing the coefficient. EPA believes this approach was appropriate in this particular product segment due to the small amount of data which made it difficult to achieve ENERGY STAR representation across the capacities using the best-fit power curve.

The Draft 2 Continuous Type Ice Maker compliance rates are somewhat higher than typical, but are more representative across all capacities and provide consumers with choice among types and manufacturers, while also more evenly representing flake and nugget systems.

Note:

Potable Water - Stakeholders generally supported Draft 1 batch potable water use levels. However, EPA received a comment that prompted EPA to look into the relationship between harvest rate and potable water use, that smaller systems may be disadvantaged. According to the data, lower harvest rate systems (< 500 lbs per 24 hrs) tended to consume more water than larger systems. However, because low water use products are available across all sizes at ≤ 20 gal per 100 lbs of ice for IMH and RCU systems, and ≤ 25 gal per 100 lbs of ice for SCU systems, EPA will retain the batch potable water use levels presented in Draft 1.

For the Continuous Type potable water use levels, stakeholders expressed concern that the Draft 1 levels set at 12 gal per 100 lbs of ice did not allow room for measurement and design tolerances and flush features, and that these ice machines require a minimum of 12 gal just to produce ice. Therefore, EPA is proposing to raise the continuous-type water level to 15 gal per 100 lbs of ice to account for these manufacturing and testing factors while continuing to ensure that water efficiency is retained with greater energy efficiencies.

EPA welcomes comments on the proposed levels, the methodology for setting the level lines, and also on the data plots that are available on the ENERGY STAR Commercial Ice Machines Specification Development webpage:
http://www.energystar.gov/index.cfm?c=revisions.commercial_ice_machine_spec

C. Significant Digits and Rounding:

- a. All calculations shall be carried out with directly measured (unrounded) values.
- b. Unless otherwise specified, compliance with specification limits shall be evaluated using directly measured or calculated values without any benefit from rounding.

Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to 0.1 for energy consumption rate and potable water.

5) Test Requirements:

- A. Units shall be selected for testing per the sampling requirements defined in 10 CFR § 429.45, which references 10 CFR § 429.11.

Note: For purposes of harmonizing with the applicable DOE test procedures, EPA has added the basic model definition and the sampling requirements to be more specific to the requirements as defined under 10 CFR section 429.45. EPA requests stakeholder comments on the approach and whether qualifying based on product families would also be applicable. EPA has limited information, and is interested in understanding whether a family approach to testing would be appropriate to ACIM products or any of the various sub-groups.

- B. When testing commercial ice machines, the following test methods shall be used to determine ENERGY STAR qualification:

Table 3: Test Methods for ENERGY STAR Qualification	
ENERGY STAR Requirement	Test Method Reference
Energy Consumption Rate (kWh/100 lbs ice)	AHRI Standard 810-2007, <i>Performance Rating of Automatic Commercial Ice-Makers</i>
Potable Water Use (gal/100 lbs ice)	

Note:

For those product categories that are covered both by DOE standards and the ENERGY STAR program, EPA is committed to harmonizing with DOE regarding the test procedures used to determine compliance. This greatly reduces confusion and burden on manufacturer partners. DOE has proposed using AHRI Standard 810-2007, in its rulemaking process. While changes may be made to the procedure, DOE has indicated that it does not anticipate these changes will impact existing performance ratings, although the process is still ongoing. EPA believes that the Version 2.0 data set will continue to represent available model performance once the test method is finalized. Once the DOE test procedure is final, EPA intends to reference the DOE test procedure, as defined in the Federal Register, in Table 3 above.

Concerns were raised regarding the AHRI Standard 810-2007 test procedure. One issue raised was the effect of water hardness variability between test facilities on the calorimeter test results, and whether the test was therefore a good indicator of ice hardness. In follow-up conversations with manufacturers, the prevalent perception was that the widest range of water hardness would not have a significant enough effect on ice hardness to warrant controlling or monitoring water hardness. Another test procedure concern was raised as to whether the calorimeter test procedure facilitates repeatable ice hardness results. EPA's discussions with manufacturers indicate that most were able to attain repeatable results within the current AHRI repeatability requirement. EPA encourages stakeholders to provide any relevant data or information regarding these test procedure specific concerns (the effect of water hardness on ice hardness measurements, and ice hardness measurement repeatability) to EPA, but it is EPA's understanding that these issues will be address as part of the DOE TP NOPR process for ACIM's.

- 6) **Effective Date:** The ENERGY STAR Automatic Commercial Ice Maker specification shall take effect on **August 1, 2012**. To qualify for ENERGY STAR a product model shall meet the ENERGY STAR specification in effect on the model's date of manufacture. The date of manufacture is specific to each unit and is the date on which a unit is considered to be completely assembled.

Note: EPA intends to finalize the Version 2.0 specification by November 1, 2011. Batch type systems that meet the requirements of this Version 2.0 may qualify immediately upon finalization if third party certified by an EPA approved Certification Body (CB). On August 1, 2012 any batch type machine that has not yet been third party certified by an EPA approved CB will be removed from the ENERGY STAR Qualified Product List and the manufacturer will be asked to cease using the ENERGY STAR mark to promote the machine(s).

- 7) **Future Specification Revisions:** EPA reserves the right to change the specification should technological and/or market changes affect its usefulness to consumers, industry, or the environment. In keeping with current policy, revisions to the specification are arrived at through industry discussions. In the event of a specification revision, please note that the ENERGY STAR qualification is not automatically granted for the life of a product model.