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

Eligibility Criteria
Draft 1: Version 3.0

Following is the **Draft 1 Version 3.0** product specification for ENERGY STAR certified 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[1]: A factory-made assembly (not necessarily shipped in 1 package) that: 1) consists of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice; and 2) May include means for storing ice, dispensing ice, or storing and dispensing ice.

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[1]: An ice maker having alternate freezing and harvesting periods. This includes automatic commercial ice makers that produce cube type ice and other batch technologies.[2]

E. Cube Type Ice[1]: Ice that is fairly uniform, hard, solid, usually clear, and generally weighs less than two ounces (60 grams) per piece, as distinguished from flake, crushed, or fragmented ice.[3]

F. Continuous-Type Ice Maker[1]: 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.

Ice Maker Categories

G. Ice Making Head (IMH)[1]: Automatic commercial ice makers that do not contain integral storage bins, but are generally designed to accommodate a variety of bin capacities. Storage bins entail additional energy use not included in the reported energy consumption figures for these units.

[1] Based on definitions in 10 CFR Part 431.132. When in conflict, the definitions in 10 CFR Part 431.132 take precedence.
[2] Referred to as cube type ice maker in AHRI Standard 810.
[3] Note that this conflicts and takes precedence over the definition established in AHRI 810 (incorporated by reference, see § 431.133), which indicates that ‘‘cube’’ does not reference a specific size or shape.

H. Remote Condensing Unit (RCU)[1] or Split System Unit: A type of automatic commercial ice maker in which the ice-making mechanism and condenser or condensing unit are in separate sections. This includes ice makers with and without remote compressor.

I. Self-Contained Unit (SCU)[1]: A type of automatic commercial ice maker in which the ice-making mechanism and storage compartment are in an integral cabinet.

Metric Definitions

J. Energy Use[1]: The total energy consumed, stated in kilowatt hours per one-hundred pounds (kWh/100 lb) of ice, stated in multiples of 0.1. For remote condensing (but not remote compressor) automatic commercial ice makers and remote condensing and remote compressor automatic commercial ice makers, total energy consumed shall include the energy use of the ice-making mechanism, the compressor, and the remote condenser or condensing unit.

K. Harvest Rate[1]: The amount of ice (at 32 degrees F) in pounds produced per 24 hours.

L. Ice Hardness Factor[1]: The latent heat capacity of harvested ice, in British thermal units per pound of ice (Btu/lb) divided by 144 Btu/lb expressed as a percent.

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[1]: All units of a given type of covered product (or class thereof) 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: EPA made updates to several terms and definitions for automatic commercial ice maker (ACIM) products to align with the U.S. Department of Energy (DOE) Final Rule (10 CFR §431). On January 11, 2012, DOE clarified its interpretation of the *Batch Type Ice Maker* and *Cube Type Ice* definitions established in AHRI 810 (incorporated by reference, see §431.133) for further explanation, please see the Final Rule (Federal Register Vol., 77, No. 7, page 1613). EPA included some notes as footnotes in this document, but has otherwise aligned the definitions with the DOE standards (10 CFR §431.132).

EPA incorporated a number of minor updates from the previous version of this specification, including: (1) modest amendments to the Automatic Commercial Ice Maker and Ice Making Head definitions; (2) altered the Energy Consumption Rate metric term to Energy Use with a minor edit to the definition; and (3) amendments to the Harvest Rate and Basic Model definitions.

Connected ACIM Definitions

Q. Communication Link: The mechanism for bi-directional data transfers between the ACIM and one or more external applications, devices or systems.

R. Demand Response (DR): Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive

payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.[4]

S. Demand Response Management System (DRMS): The system operated by a program administrator, such as the utility or third party, which dispatches signals with DR instructions and/or price signals to the ENERGY STAR ACIM products and receives messages from the ACIM product.

T. Interface Specification: A document or collection of documents that contains detailed technical information to facilitate access to relevant data and product capabilities over a communications interface.

U. Load Management Entity: Device, service or system that interacts with the product to shift, control or manage ice maker electrical usage, e.g. a DRMS or energy management system.

V. Open Standards: Communication with entities outside the ACIM that use, for all communication layers, standards:

- Included in the Smart Grid Interoperability Panel (SGIP) Catalog of Standards,[5] and/or
- Included in the NIST Smart Grid Framework Tables 4.1 and 4.2, and/or
- Adopted by the American National Standards Institute (ANSI) or another well-established international standards organization such as the International Organization for Standardization (ISO), International Electrotechnical Commission (IEC), International Telecommunication Union (ITU), Institute of Electrical and Electronics Engineers (IEEE) or Internet Engineering Task Force (IETF).

Note: EPA is proposing the addition of optional connected functionality criteria to recognize ENERGY STAR ACIM products with connected capabilities, and as such, the Agency is proposing relevant terms and definitions in Section 1. Q-V. EPA would like to provide some additional clarification on the term Load Management Entity. A DRMS is typically under the control of an electric utility or DR aggregator that sends load dispatch requests to the product. An ACIM energy management system schedules ice production throughout the day. Such a system may be programmed to minimize electrical consumption and energy costs while meeting ice production needs.

Additional information on connected criteria for ACIMs can be found in Section 4, below. EPA requests feedback on the terms and definitions provided above.

2) Scope:

A. Included Products: Products that meet the definition of an Automatic Commercial Ice Maker as specified herein that are air-cooled batch or continuous type, and of IMH, RCU, or SCU design, are eligible for ENERGY STAR qualification, with the exception of products listed in Section 2.B. Air-cooled RCUs designed for connection to remote rack compressors that are alternately sold (with the same model number) with a dedicated remote condensing unit are also eligible for ENERGY STAR qualification.

B. Excluded Products: Water-cooled ice makers, ice and water dispensing systems, and air-cooled RCUs that are designed only for connection to remote rack compressors are not eligible for ENERGY STAR qualification.

[4] FERC National Assessment & Action Plan on Demand Response, https://www.ferc.gov/industries/electric/indus-act/demand-response/dr-potential.asp

[5] http://collaborate.nist.gov/twiki-sggrid/bin/view/SmartGrid/PMO#Catalog_of_Standards_Processes

Note: EPA received stakeholder requests to consider expanding the scope of the ENERGY STAR specification to include water-cooled ACIMs. In consideration of this request, EPA performed product research and industry outreach regarding ACIM products. Although some water-cooled products may offer a slight gain in energy efficiency, based on the significant increase in water consumption for single-pass or pass-through cooling systems, EPA cannot justify the inclusion of open water-cooled ACIM products. While other water-cooled ice makers have been designed to incorporate a closed-loop cooling system in which water is re-circulated, there is no mechanism to ensure that products are limited to closed-loop cooling in operation. Several stakeholders have indicated that there are challenges associated with guaranteeing water-cooled ice makers are installed with closed-loop designs in the field. In some cases, the cost of building a water loop for ice makers may be cost prohibitive. For these reasons, water-cooled ice makers will remain excluded from the scope of this ENERGY STAR specification.

At this time, ice and water dispensing systems also remain excluded from scope. EPA may consider these products in the future. Stakeholders are encouraged to submit data explaining the effect water dispensing functions have on energy use so EPA can adequately evaluate these products in the future.

3) Certification Criteria:

A. Measure the energy use and potable water use of each covered product by conducting the test procedure set forth in Section 5. Compare the Energy Use and the measured Potable Water Use values to the ENERGY STAR minimum values presented in Tables 1 and 2.

B. Energy Use (Energy Consumption Rate): The Energy Use requirement is a function of harvest rate in the form of $L = A * H + b$, where L is the energy use requirement level, H is the ice harvest rate for the system under evaluation, A is a coefficient, and b is a constant.

Table 1: ENERGY STAR Requirements for Air-Cooled Batch-Type Ice Makers

Equipment Type	Applicable Ice Harvest Rate Range (lbs of ice/24 hrs)	Energy Use (kWh/100 lbs ice)	Potable Water Use (gal/100 lbs ice)
IMH	**H** < 1000	≤ -0.0023**H** + 6.6	≤ 20.0
	1000 ≤ **H** ≤ 1600	≤ 4.3	
RCU	**H** < 1025	≤ -0.0029**H** + 7.07	≤ 20.0
	1025 ≤ **H** ≤ 4000	≤ 4.1	
SCU	**H** < 200	≤ -0.032**H** + 11.75	≤ 25.0
	200 ≤ **H** ≤ 500	≤ 5.35	

Table 2: ENERGY STAR Requirements for Air-Cooled Continuous-Type Ice Makers

Equipment Type	Applicable Ice Harvest Rate Range (lbs of ice/24 hrs)	Energy Use (kWh/100 lbs ice)	Potable Water Use (gal/100 lbs ice)
IMH	**H** < 800	≤ -0.0026**H** + 7.0	≤ 15.0
	800 ≤ **H** ≤ 4000	≤ 4.92	
RCU	**H** < 800	≤ -0.005**H** + 8.0	≤ 15.0
	800 ≤ **H** ≤ 4000	≤ 4.0	
SCU	**H** < 700	≤ -0.006**H** + 8.5	≤ 15.0
	700 ≤ **H** ≤ 4000	≤ 4.3	

Note: EPA's main drivers for amending this specification's minimum performance levels are: 1) estimated ENERGY STAR market share of approximately 61% in 2015, and 2) the forthcoming DOE regulatory energy use requirements issued for ACIM products. When the market shows signs of transforming towards ENERGY STAR equipment, the Agency reviews new equipment designs and technologies, along with other market characteristics, to identify opportunities that offer additional savings and greater energy efficiency. Through an iterative ENERGY STAR specification revision process, EPA aims to identify the top performing products within a product category. Due to the high market share of ENERGY STAR ACIM products, EPA is revising the Version 2.0 levels to ensure ENERGY STAR continues to offer significant savings to operators and end-users. EPA has proposed updates to the ENERGY STAR performance criteria presented in Tables 1 and 2.

The data assembled for the energy performance analysis used for the proposed levels derive from the current ENERGY STAR Product Finder and the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) database. The proposed levels for continuous-type ice makers account for the ice hardness adjustment factor for each product, which is then multiplied by the measured energy use (kWh/100 lbs. ice).

In Version 2.0, EPA made use of power curves to set certification criteria in an effort to eliminate any discontinuities between different sizes or types of products. For Version 3.0, EPA is proposing to return to a linear approach, which evaluates the relationship between efficiency and harvest capacity based on available market trends and data. This approach will ensure that ENERGY STAR products offer significant savings when compared to standard models, and are available in a variety of subtypes and sizes.

EPA understands that several stakeholders are considering potential climate-friendly, low-GWP refrigerants for use in ACIM products. Based on preliminary data, upgrading to a high-efficiency compressor and switching to a more climate-friendly refrigerant and refrigeration system can improve the energy efficiency of a product by approximately 5-10% or better, depending on the specific model and capacity. While EPA understands that the charge limits of certain refrigerants may present challenges, particularly for larger capacity ACIMs, the Agency encourages the transition to low-GWP refrigerants in applicable system designs stakeholders choose to adopt. In an effort to raise the level of energy efficiency for ACIMs, while reducing the use of ozone-depleting and high-GWP substances, EPA is encouraging manufacturers to consider the early adoption of climate-friendly hydrocarbon refrigerants.

EPA will maintain the Version 2.0 potable water use requirements, but will continue to monitor technological advancements in potable water efficiency for eligible air-cooled products.

EPA is interested in looking at energy and water use for ice makers in various settings, more holistically. Specifically, EPA would like to share information that would allow end-users to better track their energy and water use in any setting that an ACIM may include. EPA is seeking more information on the various energy and water settings, and their impact on overall performance, specifically in regards to:

- The current energy and potable water use tests conducted based on "manufacturer recommended settings." EPA is interested in learning what other settings are available to an end-user and how energy and water usage varies in alternative settings (i.e. least consumptive versus most consumptive). EPA is interested in understanding how easily operators can adjust these settings.

- Do manufacturers currently collect information on the amount of water discharged from ACIM products during the dump or purge settings? What, if any, additional burden would be associated with recording a discharge value?

- EPA understands that water quality affects the ice quality. How do manufacturers advise customers about water hardness in their respective areas, getting the best product and utilizing water in the most efficient way? Would installation criteria specifying the inclusion of a water filtration device create a level playing field for comparing water usage at varying water hardness levels?

EPA encourages manufacturers to review the levels and provide feedback to the Agency on the proposed maximum energy consumption rates and the Agency's specific questions on energy and water usage.

C. Significant Digits and Rounding:

a. All calculations shall be carried out with actual measured (unrounded) values. Only the final result of a calculation shall be rounded.

b. Unless otherwise specified below, compliance with specification limits shall be evaluated using exact values without any benefit from rounding.

c. Directly measured or calculated values that are submitted for reporting on the ENERGY STAR website shall be rounded to the nearest significant digit as expressed in the corresponding specification limit.

Note: EPA has updated the rounding requirements above to avoid confusion and for consistency with other ENERGY STAR specifications.

D. Additional Reporting Requirement

a. Report the type of refrigerant used in the respective ACIM model, for example: R-404A, R-290, or R-134a.

Note: As noted in Section 3.D.a, above, EPA is proposing to require the reporting of the type of refrigerant used in the ACIM. EPA intendeds to share this information publicly on the ENERGY STAR Product Finder.

4) Connected Functionality in Automatic Commercial Ice Makers:

The following ***optional*** connected criteria are applicable to Included Products in Section 2.A:

Note: Consistent with the principle of supporting both enhanced value from connected product features as well as the broad societal benefits associated with smart grid integration; EPA has continued to evaluate how best to recognize connected and grid-interactive product functionality in ENERGY STAR specifications.

This Draft 1 reflects EPA's interest in working with ACIM stakeholders to develop ***optional*** criteria that will enable ACIMs that include connected functionality to be recognized as such. In ENERGY STAR product categories that include optional connected criteria, EPA highlights products with connected functionality on the ENERGY STAR Product Finder, so end-users, rebate programs and interested stakeholders can better identify and advance these products in the marketplace.

The proposed criteria herein this specification are largely based on the connected criteria in ENERGY STAR appliance specifications; however, EPA looks forward to collaborating with ACIM stakeholders to further develop connected criteria that are both meaningful and appropriate to current ACIM models with connected features. Inclusion of this criteria is intended to enable ACIM that include connected features that can intelligently tailor production to minimize energy use and/or expense and to participate in Demand Response programs to be recognized as connected.

A. Remote Management

The product shall be capable of receiving and responding to remote requests via a communication link that enable intelligent control of ice production in order to reduce energy use and/or energy expense. For example, such functionality could enable interconnection with an external device, or service that actively alters ice production in order to minimize energy expense when enrolled in a Time-of-Use or other time-varying electricity price program.

B. Demand Response (DR)

a. Grid Communications – The product shall include a communication link that facilitates the use of open standards, as defined in this specification, for all communication layers to enable DR functionality.

Note: *Products that enable direct, on-premises, open-standards based interconnection are preferred, but alternative approaches, where open-standards connectivity is enabled only with use of off-premise services, are also acceptable.*

b. Open Access – To enable interconnection with the product over the communication link, an interface specification, application programming interface (API) or similar documentation shall be made available that, at a minimum, enables DR functionality.

Note: *While EPA encourages broad availability of the interface spec or API, dissemination of these documents may be limited to certified/qualified developers, integration partners and other similar entities.*

c. Consumer Override – The product shall be capable of supporting DR event override-ability.

C. Capabilities Summary – A ≤ 250-word summary description of the product's Remote Management and DR capabilities/services shall be submitted. In this summary, EPA recommends noting the following, as applicable:

- Overview of Remote Management capability that the product supports, notable capabilities that can reduce energy usage or reduce energy expense.
- DR services that the product has the capability to participate in such as load dispatch, ancillary services, price notification and price response.
- Whether the product can be directly addressed via the interface specification, API or similar documentation.
- List open communications supported by the product, including applicable certifications.
- Feedback to Load Management Entity, e.g. verification/M&V, override notification.
- Measures to limit DR impacts, if any.
- DR response configurability/flexibility by the customer and/or Load Management Entity.

Note: Based on research and industry discussions, EPA understands that primary use cases for connected ACIMs are:

1) To enable intelligent Remote Management of ice production to reduce energy usage and/or offset energy costs, and

2) To offer support for Demand Response programs and smart grid integration. For example, when an ACIM is enrolled in a utility DR program, it would be capable of reducing load in response to a DR signal by delaying ice production.

The proposed connected criteria enable ACIMs that include connected criteria to be optionally recognized as connected, while allowing partners substantial flexibility for innovation. EPA encourages partners to describe and differentiate their product's connected features in the connected capabilities summary.

EPA encourages stakeholders to provide detailed feedback on additional use cases for connected ACIMs, including when an ACIM can participate in Demand Response. EPA is also interested in better understanding market availability of ACIM with connected features and how the market for such products is expected to develop. Finally, EPA welcomes input into how ENERGY STAR connected criteria could be structured to best differentiate ACIMs that include connected features.

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.

B. When testing commercial ice makers, the following test methods shall be used to determine ENERGY STAR certification:

Table 3: Test Methods for ENERGY STAR Qualification	
ENERGY STAR Requirement	**Test Method Reference**
Energy Use (kWh/100 lbs ice)	10 CFR Part 431.134
Potable Water Use (gal/100 lbs ice)	AHRI Standard 810 (I-P)-2016 *Standard for Performance Rating of Automatic Commercial Ice-makers*

Note: In an effort to align with DOE, EPA has removed the *Product Specification for Automatic Commercial Ice Makers Test Method Version 2.0*, as well as any reference to that ENERGY STAR test method in this specification. EPA has updated the test methods referenced in Table 3, to reflect the most current test procedures for determining energy and potable water use

6) Effective Date: The ENERGY STAR Automatic Commercial Ice Maker specification shall take effect on **TBD**. 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: The effective date for the ENERGY STAR Version 3.0 specification is noted as being TBD in Section 6; however, at the very latest, the specification effective date will be on or before January 1, 2018 to coincide with the effective date of the forthcoming ACIM minimum efficiency standard.

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 certification is not automatically granted for the life of a product model.