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

Eligibility Criteria
Draft 2: Version 3.0

Following is the **Draft 2 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.

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).

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.

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** < 300	≤ 9.20 - 0.01134**H**	≤ 20.0
	300 ≤ **H** < 800	≤ 6.49 - 0.0023**H**	
	800 ≤ **H** < 1500	≤ 5.11 - 0.00058**H**	
	1500 ≤ **H** ≤ 4000	≤ 4.24	
RCU	50 ≤ **H** < 1000	≤ 7.17 – 0.00308**H**	≤ 20.0
	1000 ≤ **H** ≤ 4000	≤ 4.10	
SCU	**H** < 110	≤ 12.57 - 0.0399**H**	≤ 25.0
	110 ≤ **H** < 200	≤ 10.56 - 0.0215**H**	
	200 ≤ **H** ≤ 4000	≤ 6.25	

[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

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** < 310	≤ 7.90 – 0.005409**H**	≤ 15.0
	310 ≤ **H** < 820	≤ 7.08 – 0.002752**H**	
	820 ≤ **H** ≤ 4000	≤ 4.82	
RCU	**H** < 800	≤ 7.76 – 0.00464**H**	≤ 15.0
	800 ≤ **H** ≤ 4000	≤ 4.05	
SCU	**H** < 200	≤ 12.37 – 0.0261**H**	≤ 15.0
	200 ≤ **H** < 700	≤ 8.24 – 0.005429**H**	
	700 ≤ **H** ≤ 4000	≤ 4.44	

Note: Several stakeholders commented on the inconsistent harvest rate break points when compared to the federal minimum efficiency standard. Commenters noted that in establishing different break points, certain harvest ranges within subcategory, would have stricter requirements than others. EPA acknowledges that the inconsistent break points makes energy use criteria for certain harvest ranges more challenging, in some cases resulting in lower product eligibility. EPA has amended the energy use criteria to maintain consistent harvest ranges between ENERGY STAR and the federal minimum efficiency standard.

Stakeholders also suggested that EPA consider developing separate levels for remote condensing units with remote compressors and without remote compressors to align with DOE's approach. EPA performed an analysis on the two types of RCUs. However, the performance data on the individual types was limited and developing separate performance criteria did not appear to offer customers additional energy savings beyond the approach EPA took in Draft 1. Furthermore, the federal standard has nearly identical requirements for the two types of RCUs. In fact, DOE considered whether efficiency improvements based on design options would be significantly different for remote compressor machines, when compared to non-remote compressor machines. In the end, DOE concluded that there would be little difference in efficiency improvement or cost between the two types of RCUs.[6] EPA does not see benefit to further separating the RCU category with different performance criteria.

Stakeholder support for the proposed Draft 1 levels for this specification varied. While EPA did receive support from some stakeholders, the Agency also received feedback suggesting the proposed levels did not allow for sufficient availability of certified models in all sizes. To ensure ENERGY STAR labeled ACIMs continue to offer significant savings beyond standard products, EPA has proposed updates to the ENERGY STAR performance criteria presented in Table 1. The data assembled for the energy performance analysis used for this specification revision was developed using the current ENERGY STAR Product Finder and the Air-Conditioning, Heating, and Refrigeration Institute (AHRI) database.

EPA also sought information from manufacturers on incremental efficiency gains resulting from the use of advanced available components and technologies. As mentioned above, this Draft 2 specification includes amended levels to allow for greater availability of certified models but still provide end-users with meaningful savings. EPA understands that manufacturers are still conducting research and development for new products, and performance data on those models was not available to EPA for consideration during this specification revision. However, in conversations with several stakeholders, including compressor manufacturers currently working with ACIM equipment manufacturers, EPA learned that there are several technology options that may improve the efficiency of ACIMs. EPA reviewed information on potential efficiency gains that could be made with new components and technologies. By optimizing components, including increasing the compressor energy efficiency ratio (EER), making use of climate-friendly refrigerants, and upgrading motors, manufacturers can realize significant energy efficiency improvements.

[6] DOE. 2014. Technical Support Document: Energy Efficiency Program for Consumer Products and Commercial and Industrial Equipment: Automatic Commercial Ice Makers. December 1, 2014.

Note cont.
The transition to hydrocarbon refrigerants is often accompanied by component and design changes that, in some cases, compound energy savings. Several stakeholders have demonstrated that incorporating climate-friendly hydrocarbon refrigerants, optimizing component selection with improved compressors and microchannel heat exchangers, may provide significant combined energy savings in ACIMs.

Water Quality
EPA encouraged manufacturers to expand on how water quality affects the quality of a machine's ice product. Stakeholders responded stating that it is industry standard practice for manufacturers to recommend to customers the use of a water filter or other water treatments based on the needs and quality of water in the area where the equipment is being installed. Some end users may employ whole-site water treatment systems. EPA appreciates the responses on how manufacturers advise their customers on water quality based on region. EPA may consider re-enforcing manufacturers' recommendations through education and best practice guidance efforts for this product category. However, EPA is not considering implementing a water quality (i.e., filtration) requirement at this time.

EPA received a comment from one manufacturer suggesting a reduction in the maximum potable water use levels for continuous ACIM products. EPA appreciates this feedback, and the commenter's drive to encourage water conservation. While EPA understands that some manufacturers in this market are developing additional energy and water efficient technologies, these technologies are not broadly leveraged at this time. Thus, the potable water use levels will remain unchanged in Draft 2.
EPA is interested in learning more about new technologies to advance water efficiency and may review the potable water use criteria in a subsequent specification review or revision.

EPA encourages manufacturers to review the levels and provide feedback to the Agency on the proposed maximum energy use rates.

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.

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: EPA received no objections to the inclusion of this reporting requirement. Stakeholders recommended that EPA develop a drop-down list of approved refrigerants. The Agency will consider the best option for providing a list of approved refrigerants, and believes providing a selection list would help simplify the process for recording that reporting requirement. EPA encourages stakeholders to provide a list of refrigerants used in ACIM products.

4) Optional Connected Functionality in Automatic Commercial Ice Makers:

For connected recognition, the following ***optional*** connected criteria are applicable to Included Products in Section 2.A:

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.

Note: *Based on in field studies with ACIMs supporting DR and Load Shifting strategies, EPA recommends including automatic DR/Load Shift exit points, based on ice bin levels (sensor). These exit points include a critical minimum level (often 25% bin capacity), and a sudden ice drop indicator (often 10% bin level in 5 minutes); these exit points ensure that end user ice levels are protected from sudden rushes, and from ice levels dropping below levels required for business operations.*

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, including automatic DR exit strategies, if any.
- DR response configurability/flexibility by the customer and/or Load Management Entity.

Note: EPA proposed the inclusion of optional connected functionality criteria for ACIM products. As noted in Draft 1, existing ENERGY STAR product categories that include optional connected criteria are highlighted on the ENERGY STAR Product Finder, so end-users, rebate programs and interested stakeholders can better identify and advance these products in the marketplace. EPA plans to highlight ACIMs that incorporate connected functionality in a similar way. EPA encouraged stakeholders to provide feedback on the implementation of optional connected criteria for this category and received a range of comments.

Commenters specifically raised concern regarding the potential depletion of ice at an inopportune time (i.e., during peak operating hours), which may compromise food safety requirements in some operations. Stakeholders also indicated that increasing the size of the ice bin and overall space needed for ice making and storage, to accommodate DR or Load Shifting, may not work in some space-limited operations.

EPA appreciates the feedback on the optional connected criteria for ACIMs. ENERGY STAR products with connected functionality are capable of sharing information with other devices, such as a PC, smart phone or tablet. They can offer end-users tools for understanding and managing their energy use, as well as helping them identify and avoid potential performance problems. Connected products have the potential to dramatically change the way consumers and end-users interact with products. For instance, remote diagnostic functionalities help end-users identify performance problems before they waste energy and possibly even avoid a traditional service call.

EPA understands maintaining a supply of ice may be crucial to general operations, or for health and safety reasons in some establishments. Offering connected functionality in all types and sizes of products, or for all market segments, may not be in the best interest of partners and their customers. The addition of these optional criteria allows manufacturers the opportunity to include DR capabilities and features for products in applications where it makes sense and to have that functionality highlighted on the ENERGY STAR product list. DR designs may incorporate the use of exit points. These exit points establish a minimum or critical capacity of ice to be in the storage bin at all times. If harvested ice capacity falls below the exit set point, the maker exits DR mode. These set points can be customized to meet the needs of an end-user. EPA notes that based on feedback from stakeholders, load shifting for an ACIM, is an important calculation that can be complex, and as such, end-users may benefit from expert technical assistance. The inclusion of a critical minimum ice level sensor will ensure ice needs are satisfied prior to the exhaustion of harvested ice. The Agency is confident that through utility and manufacturer collaborations, it is possible to determine which end-users are in a position to benefit the most from connected ACIMs capable of load shifting during DR events.

End-users ultimately have the ability to maintain control of their equipment, and individual responses to outside signals. Connected products incorporate the ability to override direction from a utility, in the event the timing for load shifting is inopportune. With permission, connected products can make small adjustments in how a product operates – such as shifting an ice maker's primary ice producing timing to off-peak hours when energy demand is lower, rather than the peak operating hours when energy demand is higher and energy can be more costly.

One stakeholder commented that the savings associated with DR/load shifting might not always provide a less than 2-year return on investment in terms of energy dollar savings. Based on publicly available sources of information, both energy and water savings have been realized in the field when DR and load shifting programs have been established.[7] EPA recognizes that available data is limited; however, the Agency is interested in working with partners who make the decision to develop products with this optional functionality.

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[7] Karas, Angelo, David Cowen and Don Fisher. 2011. Ice Machine Field Study: Energy and Water Saving with Ice Machine Upgrade and Load Shifting. http://www.fishnick.com/publications/fieldstudies/Ice_Machine_Upgrade_Load_Shifting_Field_Study.pdf. San Ramon, CA: PG&E Food Service Technology Center.

Note cont. ENERGY STAR products are designed to save energy, which also reduces annual energy costs. While utility programs across the country have varying energy costs for electricity and grid demand, customers who conserve energy generally see utility bill cost reductions. End-users may also benefit greatly from demand reduction programs and incentives. EPA understands that DR and load shifting may not affect energy costs in a consistent way across the entire country. However, based on characteristics of certain regions, any additional cost of incorporating DR and load shifting features may be justifiable in customer savings. End-users can still participate in partial DR/load shifting, which will exit the DR scenario once ice levels reach a predetermined level. This provides a net benefit to the utility and customer.

EPA sees opportunity for end-user convenience, energy savings, and energy shifting associated with connected functionality for these products. Therefore, EPA intends to retain the optional connected criteria for ACIMs.

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: EPA received a comment regarding the cost of testing ACIM products for ENERGY STAR certification. EPA has aligned the test method with the Federal minimum efficiency procedure to eliminate duplicative testing. Brand owners can use the same laboratory test reports from an EPA recognized lab to satisfy both DOE's and EPA's requirements.

6) Effective Date: The ENERGY STAR Automatic Commercial Ice Maker specification shall take effect on **January 1, 2018**. 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: After careful consideration of the comments received in response to the Draft 1 proposed effective date, EPA has retained the proposal of January 1, 2018. Maintaining ENERGY STAR's role as an effective differentiator of highly efficient products in the market is a priority for the Agency. An effective date of January 1, 2018, addresses the need for differentiation given the forthcoming federal 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.