CHAPTER 2. ANALYTICAL FRAMEWORK, COMMENTS FROM INTERESTED PARTIES, AND DOE RESPONSES

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CHAPTER 2. ANALYTICAL FRAMEWORK, COMMENTS FROM INTERESTED PARTIES, AND DOE RESPONSES

2.1 INTRODUCTION

The U.S. Department of Energy (DOE or the Department) is required to publish performance-based standards for automatic commercial ice-making equipment that achieves the maximum improvements in energy efficiency that are technologically feasible and economically justified. (42 U.S.C. 6313(d)(4); 6295(o)(1)–(2)) This chapter describes the analytical framework that DOE is using to evaluate new energy conservation standards for automatic commercial ice makers. The chapter sets forth the methodology, analytical tools, and relationships among the various analyses that are part of this rulemaking. The analyses performed as part of the accompanying notice and reported in this preliminary technical support document (preliminary TSD) are described in the executive summary.

DOE proposed this analytical framework in the rulemaking Framework document for automatic commercial ice-making equipment. DOE announced the availability of the Framework document in a notice of public meeting and availability of a Framework document published on November 19, 2010. 75 FR at 70852 (*i.e.*, the Framework document). DOE presented the analytical approach to interested parties during a public meeting held on December 16, 2010 to discuss the energy conservation standard Framework document for automatic commercial ice makers and receive comments from interested parties (December 2010 Framework document public meeting). The Framework document is available at www1.eere.energy.gov/buildings/appliance_standards/commercial/pdfs/acim_framework_2010_11_04.pdf.

Subsequent to the publication of the Framework document and at the public meeting, DOE received numerous comments from interested parties regarding DOE's analytical approach. This chapter summarizes the key comments and describes DOE's responses. In this chapter, DOE also summarizes any significant changes made to the analytical approach described in the Framework document and incorporated into its preliminary analyses. In the remainder of this chapter, DOE summarizes the analyses and issues as presented in the Framework document, the comments received, and DOE's responses to the comments.

2.2 GENERAL RULEMAKING ISSUES

This section summarizes comments that are not specific to any of the rulemaking analyses and presents DOE's responses to these comments.

2.2.1 Scope of Coverage: Equipment

The scope of coverage for the automatic commercial ice-making equipment rulemakings is derived from the amendments to the Energy Policy and Conservation Act (EPCA) in the Energy Policy Act of 2005 (EPACT 2005), Pub. L. 109-58. These amendments prescribe energy

conservation standards for cube type automatic commercial ice makers that produce between 50 and 2,500 pounds of ice per 24 hours (lb/24 hours),[a] and condenser water usage standards for cube type ice makers of this same harvest capacity range that use water for condenser cooling purposes. (42 U.S.C. 6313(d)(1)) The EPACT 2005 amendments to EPCA also grant DOE authority to set standards for types of automatic commercial ice makers that are not covered by the standards contained in EPACT 2005. (42 U.S.C. 6313(d)(2)(A)) Analyzing the need for standards governing energy usage in automatic commercial ice-making equipment not covered by standards in 42 U.S.C. 6313(d)(1) is a primary purpose of this rulemaking.

2.2.1.1 Harvest Capacity Extension

In the November 2010 Framework document, the Department asked whether coverage should be expanded to include ice makers producing from 50 up to 10,000 lb/24 hours from the current covered capacity range of 50 to 2,500 lb/24 hours. The Department received several comments from interested parties in response to the statements in the November 2010 Framework document, which are laid out below.

The Air-Conditioning, Heating, and Refrigeration Institute (AHRI) commented that a 4,000 lb/24 hours harvest capacity is the limit between commercial and industrial ice makers. AHRI added that, beyond 4,000 lb/24 hours, machines are industrial, which AHRI stated is outside the scope of this rulemaking. AHRI supported limiting the scope to equipment with harvest capacities up to 4,000 lb/24 hours. (AHRI, Public Meeting Transcript, No. 13 at p. 65)[b] AHRI further commented that EPACT 2005 gave DOE authority to develop commercial standards only. (AHRI, No. 16 at p. 2)

Scotsman Industries (Scotsman) questioned the need to extend the capacity to 4,000 lb/24 hours. (Scotsman, No. 22 at p. 1) Scotsman also indicated they can accept extending the range to 4,000 lb/24 hours. (Scotsman, No. 22 at p. 3)

Manitowoc Ice (Manitowoc) opined that it is unlikely that there would be any appreciable market for commercial ice machines larger than 4,000 lb/24 hours capacity due to the required physical size of the machine and the associated storage bin, and end user preference for distributed application of ice machines in large use venues (casinos, stadiums, etc.) due to the handling considerations for large quantities of ice. Manitowoc added that industrial production of ice (delivery companies or direct industrial uses) should not be included in this rulemaking due to the very different nature of the facilities, equipment, and business model, and that the capacity limit should be 4,000 lb/24 hours. (Manitowoc, No. 19 at p. 1)

Hoshizaki America, Inc. (Hoshizaki) suggested setting the upper capacity of commercial ice machines at 4,000 lb/24 hours, adding that larger harvest capacities would be considered

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[a] For brevity, pounds of ice per 24 hours will be referred to herein as lb/24 hours.

[b] A notation in this form provides a reference for information that is in the docket of DOE's rulemaking to develop energy conservation standards for automatic commercial ice makers (Docket No. EERE-2010-BT-STD-0037), which is maintained at www.regulations.gov. This notation indicates that the statement preceding the reference is document number 13 in the docket for the energy conservation standards rulemaking for automatic commercial ice makers, and appears at page 65 of that document.

industrial and a different family of machines than commercial ice machines. (Hoshizaki, No. 18 at p. 1)

Pacific Gas and Electric Company and Southern California Edison (California Investor-Owned Utilities (IOUs)) and Southern California Gas Company and San Diego Gas and Electric (Sempra) commented that, although public information is not available regarding the market share of commercial ice makers with harvest capacities from 2,500 to 4,000 lb/24 hours, they supported coverage of these units based on the updated AHRI Standard 810-2007, provided new standards meet DOE's criteria as outlined by EPCA. (California IOUs, No. 17 at p. 2; Sempra, No. 20 at p. 2)

Vogt Ice (Vogt) suggested that energy conservation standards should include energy ratings up to at least 10,000 lb/24 hours. Vogt commented that, while previous energy standards have only considered the ice manufactured by one machine, many customers use multiple smaller machines to get the total capacity of ice that they need. Vogt stated that this approach results in the customer using more water and electricity per pound of ice produced than they would have by using one machine with a higher capacity. Vogt added that, if the objective of the energy conservation standards is to lead customers to make more intelligent choices about using energy to make ice, then there should be some consideration to use a high-capacity machine instead of several lower capacity machines. (Vogt, No. 23 at p. 1)

In jointly filed comments, the American Council for an Energy-Efficient Economy (ACEEE), the Natural Resources Defense Council (NRDC), and the Appliance Standards Awareness Project (ASAP), herein referred to as the Efficiency Advocates, encouraged the industry and the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) to develop an alternative rating method to allow informed industrial customers to make intelligent choices. The Efficiency Advocates were not convinced that establishing a Federal energy standard or test procedure for capacities above 4,000 lb/24 hours should be a high priority for the Department. (Efficiency Advocates, No. 15 at p. 2)

The Department accepts the position of most of the industry that 4,000 lb/24 hours is a reasonable cut-off point for automatic commercial ice makers. All commenters agreed with expanding the harvest capacity coverage, and all but one of the commenters supported or accepted an upper harvest capacity cap of 4,000 lb/24 hours, consistent with the current AHRI test procedure. AHRI Standard 810-2007 is consistent with what most manufacturers believe to be the range of commercial capacities. Most commenters referred to ice makers with harvest capacities above 4,000 lb/24 hours as industrial. Therefore, in the preliminary analysis the Department elects to set the upper harvest capacity limit to 4,000 lb/24 hours, consistent with the majority of comments.

2.2.1.2 Continuous Ice Makers

This section and the sections that immediately follow discuss extension of coverage and regulation of ice makers that produce types of ice other than the cube ice for the standards initially established by EPACT 2005. Cube ice is a hard, clear ice that is well suited to beverage service where clarity and hardness of the ice are important, and uses where hard, slow-melting ice is desirable. Flake ice finds wide use where a clear, hard cube is not needed. The product is a

flake of "soft" ice with high liquid water content, frequently used to chill food such as seafood in food sales establishments and salad bars in foodservice establishments. Nugget ice is made in the same way as flake, except that the flake ice is recombined into chunks or nuggets of ice. Nugget ice is frequently used in colored beverages where the clarity of the ice and the speed at which it melts is deemed less important. Nugget ice is sometimes referred to as chewable ice.

EPCA authorizes DOE to set standards for types of automatic commercial ice makers not covered by the initial standards set by EPACT 2005. (42 U.S.C. 6313(d)(2)(A)) Both flake and nugget ice machines can be classified as "continuous" ice makers in that they produce and harvest ice simultaneously, as opposed to a batch process. In the Framework document, DOE sought comment on consideration of establishing energy conservation standards for continuous ice makers.

Scotsman supported adoption by DOE of the new test procedures developed for continuous ice makers as incorporated into the latest revisions of ASHRAE Standard 29, *Method of Testing Automatic Ice Makers* (ASHRAE 29-2009), and AHRI 810-2007 test standards. These new test procedures address flake and nugget ice and include an ice hardness measurement for continuous ice makers. (Scotsman, No. 22 at p. 1) While Scotsman's comment specifically addressed the test procedure, it also implied support of establishing energy conservation standards for continuous ice makers.

The California IOUs and Sempra supported DOE's decision to promulgate new standards for ice maker categories that were previously uncovered, specifically ice maker equipment that utilizes continuous type ice-making processes, such as flake and nugget machines, based on recent updates to the test procedure. (California IOUs, No. 17 at p. 1; Sempra, No. 20 at p. 1)

DOE intends to propose energy conservation standards for continuous ice makers in the capacity range 50 to 4,000 lb/24 hours as part of this rulemaking.

2.2.1.3 Tube Ice Makers

Several parties commented that tube ice makers, to the extent they are commercial equipment, belong in the batch product category. Batch ice makers make ice in alternating freezing and harvesting phases of operation. This broad category includes cube type ice makers. Tube ice makers range in size up to and well above 10,000 lb/24 hours.

Scotsman commented that tube machines are batch machines because tube machines work the same way as batch machines, using fundamentally the same process. (Scotsman, Public Meeting Transcript, No. 13 at p. 82)

Hoshizaki supported including tube ice makers with the batch type machines with harvest capacities between 50 and 4,000 lb/24 hours. (Hoshizaki, No. 18 at p. 1)

Manitowoc commented that tube ice machines do not necessarily require a separate equipment class, as they produce ice using a batch process like all cube type machines. Manitowoc stated that, in establishing the minimum requirements for the extended capacity range for cube type machines, which is where current models of tube ice machines exist, it is critical that DOE carefully evaluate the performance of these machines using ASHRAE 29 and

AHRI 810, as the tube machines are not currently being tested using these test procedures. (Manitowoc, No. 19 at p. 2)

The Efficiency Advocates commented that tube type ice makers should be subject to standards appropriate for the customer amenity and size categories in which they are sold. (Efficiency Advocates, No. 15 at p. 3) However, the comment did not provide specifics regarding categorization of these ice makers (*i.e.*, specification of appropriate equipment class). These comments emphasize that tube ice machines are batch ice machines. They also imply that existing EPACT 2005 energy standards for cube ice machines could potentially cover all batch machines. Note, however, that DOE applies the current standards only to automatic commercial ice makers of the regulated harvest capacity range that make ice fitting DOE's definition of cube type ice (see 10 CFR 431.132). Tube ice machines of the covered capacity range that produce ice that fits the definition for cube type ice are covered by the current standards, whether or not they are referred to as cube type ice makers within the industry. In this rulemaking, DOE is considering adopting the commenters' suggestions by including all tube ice makers and other batch ice machines (if any) that produce ice that does not fit the definition of cube type ice in this rulemaking. DOE is also considering renaming equipment classes and including batch type ice makers that produce cube type ice and batch type ice makers that produce other than cube type ice in a single equipment classification, referred to as "batch type ice makers." The automatic commercial ice maker test procedure has already adopted a definition of batch type ice makers that is consistent with this approach. 77 FR 1591 (Jan. 11, 2012). As discussed earlier, DOE has accepted the general consensus that commercial ice maker harvest capacities should extend from 50 to 4,000 lb/24 hours.

2.2.1.4 Block Ice Makers

In the Framework document, DOE stated its intent to not include block ice-making machines in this rulemaking, and sought comment. Block ice is an ice type commonly used for refrigeration and sculptures. Like cube ice, block ice is made with a batch process involving alternating periods of freezing the ice and warming the ice molds to allow ice harvest. However, in contrast to cube ice makers, block ice uses a manual process that is not fully automated. Block ice makers typically produce blocks of solid ice, weighing between 8 and 275 lb.

In the initial market assessment work, DOE investigated whether block ice makers should be included in the commercial ice maker rulemaking. Through Internet searches and contact with trade associations, DOE identified a number of different machines making block ice weighing 8 lb or more. DOE concluded that the manufacture and use of such machines was fundamentally different from other commercial ice makers. The manufacturing is highly customized, serving a niche industry. Also, the equipment requires manual operation to fill molds with water and dump finished ice blocks from the mold—hence, these machines cannot be considered "automatic" ice makers. Several interested parties commented during the Framework period on DOE's initial intention not to extend coverage to this equipment.

Manitowoc commented that block ice makers are not applied in commercial applications, falling instead under industrial ice production for delivery to retail establishments or for specialty use. As such, Manitowoc believed that block ice makers should not be included in the scope. (Manitowoc, No. 19 at p. 1)

Scotsman supported DOE's position that coverage of block ice machines is inappropriate, stating that block ice makers are a tiny, niche portion of the market. (Scotsman, No. 22 at p. 2)

AHRI stated that block ice should not be included as an equipment class at this time. (AHRI, No. 16 at p. 2)

DOE has eliminated block ice-making machines from further consideration in this rulemaking. DOE agrees with commenters that these are industrial machines that represent a very small portion of the overall ice maker market.

2.2.1.5 Chipped Ice

In performing preliminary market assessment work, DOE found references to chipped and cracked ice. DOE sought comments related to these ice types in the Framework document. DOE also determined that different manufacturers may use different nomenclature to refer to similar ice types, and that different ice-making processes may produce an ice product that looks very similar and is referred to by the same name (*e.g.*, flake ice could be made using a continuous method or batch method).

ASAP encouraged DOE to make sure that all of these types of ice makers are covered, regardless of the classification. (ASAP, Public Meeting Transcript, No. 13 at p. 61)

Scotsman explained that making chipped ice entails first making cube ice and then using one of a number of different devices to crush the cube. (Scotsman, Public Meeting Transcript, No. 13 at pp. 60–61)

The comments suggest that chipped and cracked ice makers may not represent distinct ice maker types, but may instead be part of the batch ice maker category, although the product they make is similar to the product from continuous type ice makers. However, DOE has proposed to differentiate ice makers based on the ice-making process, continuous or batch. As such, DOE intends to cover these ice makers under this rulemaking as batch ice machines, provided their harvest capacity is within the 50 to 4,000 lb/24 hours range.

2.2.1.6 Secondary Coolant Applications

In the proceedings for other equipment efficiency rulemakings related to refrigeration equipment, a significant question frequently arises related to the regulation of secondary coolant applications. Thus, in the Framework document, DOE asked for information confirming or denying the presence of secondary coolant applications in the automatic commercial ice-making industry.

Scotsman, the only commenter on this issue, stated that they know of no ice makers using a secondary cooling loop, so this should not be included. (Scotsman, No. 22 at p. 6)

DOE does not intend to consider coverage for ice machines using secondary cooling loops in this rulemaking, as none currently exist.

2.2.1.7 General Comments on Equipment Scope of Coverage

ASAP commented that they would like to ensure that all types of ice makers are covered, including combination soda-ice machines and ice makers that produce chipped or crushed ice. (ASAP, Public Meeting Transcript, No. 13 at p. 15)

Scotsman also asked if the scope of the program is to cover self-contained units that also have dispensing capabilities, and asked how they would be classified. (Scotsman, Public Meeting Transcript, No. 13 at p. 119)

Manitowoc supported DOE in setting efficiency levels for cube type machines larger than the current regulatory limit and for continuous type (flake and nugget) machines within the new capacity range, and did not see a need to create any additional equipment classes beyond batch and continuous for automatic commercial ice makers. (Manitowoc, No. 2 at p. 2) These comments, received before the Framework public meeting, presumably refer to the harvest capacity range cited in the Framework document, 50 to 4,000 lb/24 hours.

The Efficiency Advocates supported extending standards to all ice maker categories that have substantial sales volumes, energy use, and utility close enough to covered products with which they compete in the market, including flake, nugget, and tube type ice-making machines, to avoid distorting the market and to save energy. (Efficiency Advocates, No. 15 at p. 3)

Some of these comments simply confirm interested party positions already addressed in one or more of the previous sections.

In response to several of the comments, DOE intends to extend coverage to ice makers that make forms of ice other than those currently covered as cube ice, including chipped ice, crushed ice, cracked ice, flake ice, nugget ice, and tube ice, and intends to separate all of these types into batch and continuous categories. As discussed in section 2.2.1.4, DOE does not plan to set standards for block ice machines.

In response to the ASAP comment and Scotsman question, upon completion of this rulemaking the Department expects that all ice makers producing ice within the covered harvest range will be covered equipment. However, some equipment may combine ice production, storage, and ice dispensing in a single package. The ice-making function of such equipment would be covered by the standards to be developed in this rulemaking.[c]

The potential coverage of the ice storage functions of self-contained ice makers is discussed in section 2.2.4.2.

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[c] DOE is also aware of products combining water dispensing with ice production, storage, and dispensing. DOE considers such products to be subject to coverage under this rulemaking. Also, although DOE is not aware of equipment combining beverage dispensing (*e.g.*, soda) with ice production, storage, and/or dispensing, the coverage status of equipment combining all of these functions has not been determined.

2.2.2 Scope of Coverage: Consumption

2.2.2.1 Regulation of Potable Water

In the Framework document, DOE asked two questions about potable water. First, should the efficiency standards seek to set maximum usage limits for potable water? Second, should the potable water standard for water-cooled ice makers be separate from a condenser water standard, or should DOE set one standard for total water usage?

The Efficiency Advocates supported establishing an appropriate potable water use standard for each class of ice maker. (Efficiency Advocates, No. 15 at p. 3) The Efficiency Advocates also wanted separate metrics for potable water use and condenser water use rather than a combined or total water use metric. (Efficiency Advocates, No. 15 at p. 6)

The California IOUs and Sempra recommended that DOE propose a potable water use requirement for all commercial ice makers to limit the amount of water used to produce ice, and suggested that this potable water use requirement be separate from the condenser water use requirement. (California IOUs, No. 17 at p. 3; Sempra, No. 20 at p. 3)

ASAP supported a water efficiency metric for potable water consumption and believed there are still significant opportunities for water savings. (ASAP, Public Meeting Transcript, No. 13 at pp. 15–16)

AHRI commented that the clarity of ice and the prevention of scaling (solids in the water coming out of the solution and adhering to ice maker surfaces) directly depend on the quantity of the water used. AHRI believed it is imperative that DOE carefully study this issue as the utility of the product could be negatively impacted by reducing the water usage to make ice. (AHRI, No. 16 at p. 3)

Hoshizaki commented that potable water efficiency is laudable, but more studies need to be done to establish water saving potential. Hoshizaki added that total water use is not a good water metric, stating that most water-cooled machines use closed-loop systems, and that condenser water use is usually much higher than potable water use, so combining the two would skew the true value of the water used. (Hoshizaki, No. 18 at pp. 1–2)

Scotsman commented that providing two separate values for potable water use and condenser water use allows both DOE and the consumer to judge machines based on how efficiently they use the two different types of water. (Scotsman, No. 22 at p. 4) Scotsman stated that if potable water usage is reduced too far, one starts to encounter difficulties like the ice becoming cloudy and soft, which is undesirable. Scotsman went on to state that impurities in the water tend to coat all the different parts in the ice machine, requiring more frequent cleaning and/or causing reliability issues for the end user. (Scotsman, Public Meeting Transcript, No. 13 at p. 94) Manitowoc agreed with Scotsman's point about maintenance issues. (Manitowoc, Public Meeting Transcript, No. 13 at p. 95)

Manitowoc did not favor a combined potable and condenser water metric because the condenser uses significantly more water than the amount of potable water used to make ice. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 96–97) Manitowoc also opposed a

separate potable water regulation, stating that such a regulation is unnecessary and could unintentionally increase the real-life energy consumption of commercial ice machines. Manitowoc further stated that regulating energy efficiency will naturally drive designs to the lowest practical potable water use. (Manitowoc, No. 19 at pp. 2–3)

The Department is considering not regulating the use of potable water in commercial ice makers at this time. DOE bases this preliminary determination on two factors.

A major factor in the Department's deliberations is that Congress, in setting standards for automatic commercial ice makers, explicitly chose not to regulate potable water when establishing the current ice maker efficiency standards for cube ice makers. EPACT 2005 set cube ice maker standards requiring water-cooled machines to meet specific maximum allowable condenser water use levels. (42 U.S.C. 6313(d))[d] Water used for ice production—referred to as potable water—was not regulated by EPACT 2005, and the footnote to the table in 42 U.S.C. 6313(d)(1) indicates that Congress knowingly set condenser water standards only. In addition, Congress did not state that DOE should set standards for potable water when DOE reviews the standards established in EPACT 2005 or sets standards for other types of equipment. In short, Congress set forth the requirement to regulate water usage when it set condenser water standards but did not provide DOE with a clear direction on regulating potable water used in making ice. Thus, DOE has no clear Congressional mandate with respect to setting potable water limits.

Additionally, as the manufacturers commented, there is a point below which decreasing the potable water usage could cost consumers more for maintenance, could increase field energy use, and might decrease the reliability of the ice maker. Manufacturers made clear that modeling the interactions between water and energy is not simple. Manufacturers acknowledged the correlation between decreasing water usage and decreasing energy usage in rating tests, but as described in the Manitowoc comments, reduced water usage can actually increase real-world energy usage.[e] Consideration of the reduction of potable water use as a technology option is discussed in more detail in section 2.3.2.1.

While there is generally a positive relationship between energy use and potable water use in rating tests, DOE understands that, at a certain point, the relationship between potable water use and energy consumption reverses due to scaling. Without a clear mandate from Congress on potable water use generally, and given that Congress chose not to regulate potable water use for cube type ice makers by statute, DOE will likely not include potable water limits in the efficiency standards for automatic commercial ice makers.

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[d] The table in 42 U.S.C. 6313(d)(1) states maximum energy and condenser water usage limits for cube type ice machines producing between 50 and 2,500 lb/24 hours. A footnote to the table states explicitly the water limits are for water used in the condenser and not potable water used to make ice.

[e] As explained in comments by Manitowoc, as ice is formed in batch machines, dissolved solids are concentrated in the remaining water. As the concentration increases, more of the dissolved solids are deposited on the evaporator surfaces (these deposits are called scale). Scale impedes efficient heat transfer, causing it to take longer to freeze the water into ice. It can also increase the time needed to harvest the ice from the evaporator. Increased harvest time incurs a double penalty of additional harvest energy consumption and increased ice meltage during the harvest cycle. (Manitowoc, No. 19 at pp. 2–3)

2.2.2.2 Regulation of Condenser Water

EPACT 2005 set standards for the maximum amount of water that water-cooled cube ice makers (with harvest capacities between 50 and 2,500 lb/24 hours) could use. In the Framework document, DOE did not seek specific input about inclusion of condenser water usage limits. However, condenser water is an important issue and many interested parties commented on condenser water use.

At the Framework public meeting, there were many comments on condenser water related to the potential efficiencies of closed-loop systems. The two main points are illustrated by the following Efficiency Advocates and Scotsman comments.

The Efficiency Advocates stated that it is critical that the Department differentiate between two very different classes of water-cooled condensers. The Efficiency Advocates continued that "once-through" or "open-loop" systems may use potable or non-potable water, but the water is only used once and then dumped into some form of drain to a sewer or equivalent water treatment system. The Efficiency Advocates further stated that, in contrast, "closed-loop" systems use the water to move heat to a remote location for transfer to the ambient air or to equipment that may have use for the heat. In such systems, the water consumption is negligible or much less than the water flow rate through the condenser. As an example, the Efficiency Advocates pointed out that a convenience store might feed heat rejected by all refrigeration units, including ice makers, into the common water circulation loop; this heat can then be beneficially used for water heating, or even for ice melting during harvest cycles. (Efficiency Advocates, No. 15 at p. 5)

Scotsman pointed out that manufacturers of automatic commercial ice makers do not control the end use of the machine, adding that the manufacturer makes water-cooled machines but has no control over whether it is installed with a closed-loop or an open-loop, "pump and dump" system. (Scotsman, Public Meeting Transcript, No. 13 at pp. 89–90)

Manitowoc asked if DOE has the ability to consider relaxing the current limitation on condenser water flow rate if it showed enough potential benefit from an energy use standpoint. Manitowoc stated that it did not know how one weighs water and energy in a combined regulation (*i.e.*, what is more important, energy or water?). (Manitowoc, Public Meeting Transcript, No. 13 at pp. 104–105)

The Efficiency Advocates pointed out that experience with other water-cooled equipment suggests that there is likely to be an optimum flow rate with a fairly wide flow bandwidth. The Efficiency Advocates stated that a rating method should not encourage manufacturers to test at high flow rates that are unlikely to be economical for equipment owners, as the benefits of much higher flow may be small increases in efficiency. (Efficiency Advocates, No. 15 at p. 3)

AHRI commented that there is a tradeoff between condenser water usage and energy usage that should be carefully analyzed by DOE. (AHRI, No. 16 at p. 3)

Manitowoc suggested defining a performance credit for heat recovery from the refrigerant system in a commercial ice machine. (Manitowoc, No. 19 at p. 4)

DOE agrees in concept with the comments about the efficiency of closed-loop systems. The potential benefits are many. However, DOE's regulatory authority extends solely to the manufacturing of units and not to the installation of units. Hence, the regulations can neither require closed-loop installation of water-cooled units nor apply a credit for use of the condenser waste heat for heat recovery.

DOE is considering retaining the breakdown of classes that provides a clear distinction between air-cooled and water-cooled units. This allows for the possibility of the closed-loop systems advocated by the Efficiency Advocates and others. In addition, in order to develop parallel, balanced standards, DOE will develop condenser water usage limits for all relevant equipment classes that are not yet covered and consider adjustment of condenser water limits for equipment classes that are currently covered.

DOE's review of the development of existing condenser water regulations suggests that the regulations were included in the energy conservation standards primarily to prevent excessive water waste in the process of achieving an energy efficiency improvement.[f] In this rulemaking, DOE intends to adopt the same approach in establishing condenser water standards. DOE's clear mandate concerns energy efficiency, so DOE's analyses will focus on energy efficiency. In setting standards, DOE must consider engineering factors and consumer economics. Therefore, DOE is considering a proposal to set condenser water standards at levels that will preclude water waste arising from possible efforts to increase water use dramatically in order to meet standards, but the analyses will be energy-centric and will consider economics associated with water consumption to preclude wasteful condenser water usage. The proposed analyses are explained in more detail in section 2.5.2.

EPCA includes anti-backsliding provisions that prohibit the relaxing of certain energy efficiency standards. These provisions cover consumer products (42 U.S.C. 6295(o)) and certain commercial products, including automatic commercial icemakers (42 U.S.C. 6313(d)(4)). These provisions, however, do not apply to condenser water use in automatic commercial ice makers. Therefore, an increase in condenser water use would not be considered backsliding under the statute. DOE will therefore consider an increase in condenser water use as a design option to improve energy efficiency, but recognizes that such an approach must consider the cost-effectiveness of this design option based on the end user's water cost. DOE will consider using this approach to evaluate adjustment of condenser water consumption standards for currently regulated water-cooled ice makers, and to evaluate potential condenser water consumption standards for water-cooled ice makers for which DOE is currently proposing to develop standards (*i.e.*, continuous ice makers, batch type ice makers that produce ice not fitting the DOE definition for cube type ice, and equipment with harvest rates between 2,500 and 4,000 lb/24 hours).

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[f] Available documents that provide information on EPACT 2005 automatic commercial ice maker standards, and their precedents—California Energy Commission standards and Consortium for Energy Efficiency guidelines—contain evidence of fairly rigorous examinations of the energy efficiency but little evidence concerning the examination of condenser water.

2.2.3 Timing of the Rulemaking

As discussed in section 2.2.1, EPCA, as modified by EPACT 2005, grants DOE authority to set standards for types of automatic commercial ice makers that are not covered by the standards contained in EPACT 2005. (42 U.S.C. 6313(d)(2)(A)) DOE began this rulemaking process with the publication in the *Federal Register* of the notice of a public meeting and availability of the Framework document on November 19, 2010. 75 FR at 70852.

EPACT 2005 established energy conservation standards for cube type ice makers with harvest capacities between 50 and 2,500 lb/24 hours. (42 U.S.C. 6313(d)(1)) EPACT 2005 also modified EPCA to direct DOE to issue a final rule by January 1, 2015 to determine whether amendments to the standards prescribed in EPACT 2005 are technologically and economically justified. (42 U.S.C. 6313(d)(3)(A)) Consequently, a second objective of this automatic commercial ice maker rulemaking is to review and, as appropriate, revise the standards established in EPACT 2005 for cube ice makers with harvest capacities between 50 and 2,500 lb/24 hours. These standards have been in effect since January 1, 2010. Several interested parties commented on DOE's timing and scope of coverage.

In response to the Framework document, AHRI stated that DOE should not spend its resources on EPACT 2005 products because the full impact of the energy conservation standards will not be known until 2013 or later, and DOE should focus on new products—cube ice machines with capacities between 2,500 and 4,000 lb/24 hours and continuous (flake and nugget) machines with capacities between 50 and 4,000 lb/24 hours. (AHRI, No. 16 at p. 2)

Manitowoc commented they have been within the scope of the cube ice maker efficiency standards for a little less than a year and it is too soon to consider changing the cube machine standards because there has been relatively little change in the technology available to manufacturers. (Manitowoc, Public Meeting Transcript, No. 13 at p. 17)

Sempra and the California IOUs commended DOE for initiating this rulemaking a year earlier than initially scheduled to ensure that energy savings are realized sooner. (Sempra, No. 20 at p. 1; California IOUs, No. 17 at p. 1) Both parties supported amending the existing standards for cube type machines. (Sempra, No. 20 at p. 2; California IOUs, No. 17 at p. 2)

The Efficiency Advocates commented that the only concern now is the possibility that the proposed accelerated schedule for this rulemaking may over-compress the time required to carry out, publish, and allow interested parties to digest and respond to findings of the analytical processes the Department will undertake. (Efficiency Advocates, No. 15 at p. 6)

As the Efficiency Advocates suggested, DOE will take the steps to ensure adequate time is allotted for presenting rulemaking analyses and that interested parties have sufficient time to respond.

In response to AHRI and Manitowoc, DOE points out that the EPACT 2005 amendments to EPCA set standards for cube ice makers and gave DOE authority to set standards for other types of equipment. (42 U.S.C. 6313(d)(1) and 6313(d)(2)) The EPACT 2005 amendments to EPCA also require DOE to conduct a rulemaking to determine whether to amend the standards for automatic commercial ice makers established under 42 U.S.C. 6313(d)(1). If it decides to

amend the standards, DOE must publish a final rule establishing such amendments to the standards established in EPACT 2005 by January 1, 2015. (42 U.S.C. 6313(d)(3)(A))

While DOE acknowledges that additional data could become available if the review were postponed, given that the average rulemaking takes 3 years to complete, DOE could not postpone the review of the standards established in EPACT 2005 for much more than 1 year without the risk of missing the statutory deadline. Rather than waiting to see if additional data may be available, DOE elected to pursue a more resource-efficient path. As discussed above, DOE initially decided to start this rulemaking to address ice makers that are not yet covered for which EPCA grants DOE regulatory authority. These currently unregulated ice maker categories include important equipment types that may represent significant market share and national energy use. Pursuant to the authorization to establish standards for these equipment types, DOE elected to initiate a rulemaking. Because rulemakings impose burdens on both DOE and the interested parties that participate in them, and because the delay of a rulemaking addressing cube type ice makers could be no more than a year, the most efficient course of action was to accelerate development of new energy conservation standards for cube type icemakers, thus combining all commercial ice maker types in the same process.

2.2.4 Consumption Metrics

2.2.4.1 Off Mode and Standby Mode

In the Framework document, the Department indicated that it would not be developing test procedures for measurement of standby and off mode energy use, and that the energy conservation standards would not regulate this energy use. DOE asked for comment on standby and/or off mode energy use of ice makers.

When asked if manufacturers could put a quantitative estimate on standby mode energy usage, Manitowoc stated that it is probably approximately 10 watts. (Manitowoc, Public Meeting Transcript, No. 13 at p. 143) Similarly, Scotsman indicated that ice-making machines that have electronic controls—which includes most machines—use some off mode energy to keep their electronics functioning, and it is a small fraction of the energy used when the machine is making ice. Scotsman added that existing test procedures for ice machines do not measure off mode or standby mode energy consumption. (Scotsman, No. 22 at p. 6) Manitowoc commented that the worst case is an ice machine with an electronic control where there are small energy losses in the power supply transformer. Manitowoc further stated that, when the machine is not making ice and everything is turned off, all that is left is the transformer loss in the power supply, and that for ice machines with mechanical controls, the losses are zero. According to Manitowoc, if one looks at the percentage of time an ice machine is on and the percentage it is off, the off time energy usage represents less than one half of one percent of its total energy use. Manitowoc stated that this level would not justify the additional test procedures to encourage more efficient transformers for off mode. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 140–141)

These comments support DOE's belief that it should not regulate standby and off mode energy use for automatic commercial ice makers. In the recently published automatic commercial ice maker test procedure final rule, DOE found that it was unable to collect sufficient information regarding standby mode energy use to support the promulgation of a standby mode test

procedure within the scope of the rulemaking. 77 FR 1591 (Jan. 11, 2012). DOE will therefore not be considering standby energy as part of this energy conservation standard rulemaking.

2.2.4.2 Energy Use Associated with Ice Storage

ASAP asked if DOE proposed to include any energy use associated with ice storage as part of the standards. (ASAP, Public Meeting Transcript, No. 13 at p. 83) The California IOUs and Sempra observed that Canadian regulations already include a standard for the ice storage function of ice maker products with integrated storage bins, and strongly urged the Department to investigate including an appropriate requirement for ice storage bins in this rulemaking, such as a minimum R-value or a minimum storage effectiveness requirement, for applicable products. (California IOUs, No. 17 at p. 4; Sempra, No. 20 at p. 4)

Conversely, AHRI commented that ice storage was outside of the scope of the rulemaking, and that DOE was directed to examine the energy used to make the ice. AHRI added that energy is used in the making of the ice; after that, it is largely out of the ice machine manufacturer's hands and there is no energy being put into the storage bin. (AHRI, Public Meeting Transcript, No. 13 at p. 84) Scotsman agreed with AHRI's comment that energy is being put into the making of the ice, and after that it is out of the manufacturer's hands and there is no more energy being put into the storage bin. (Scotsman, Public Meeting Transcript, No. 13 at p. 83)

Manitowoc suggested that regulation of storage efficiency should be considered in a separate rulemaking, stating that a storage bin rulemaking would involve a broader group of interested parties, including the manufacturers of storage bins, beverage dispensers, carts, totes, and other equipment in which ice is stored after it is produced. Manitowoc added that it would be overly complicated to integrate consideration of ice storage into this rulemaking, and recommended that DOE handle storage separately. (Manitowoc, Public Meeting Transcript, No. 13 at p. 84–85)

The Efficiency Advocates asked DOE to consider whether a separate standard should be developed for product classes where the thermal properties of integral storage systems may be relevant for energy consumption and customer utility. The Efficiency Advocates recognized that this would not be easy, citing specifically the need to provide ice users with easy access to ice contained in the storage bin while minimizing heat gain. (Efficiency Advocates, No. 15 at p. 5)

Manitowoc commented that if DOE regulated the ice storage component of self-contained ice makers, by accounting for the loss of ice due to heat transfer through that storage section, DOE would be treating self-contained units differently than all of the other classes. Manitowoc added that storage associated with non-self-contained units also involves losses due to melting. Manitowoc stated that in this case, the bin or other storage equipment is made by a different manufacturer, and incorporating the energy use associated with meltage in the storage bin would create a double standard. (Manitowoc, Public Meeting Transcript, No. 13 at p. 86)

While DOE acknowledges stakeholders' concerns regarding storage bin effectiveness, DOE has determined that it will not pursue a measure for storage bin effectiveness at this time. Many ice makers do not have integral ice storage (these are the ice-making head and remote condensing ice maker configurations). These ice makers can be paired with any number of

storage bin models, including models produced by other manufacturers, and they are typically paired in the field upon installation. DOE does not have sufficient information on these pairings to regulate the products at this time. Furthermore, while DOE notes that it could set standards solely for self-contained units here, given that it establishes different equipment classes in part because products with different characteristics must be treated differently, DOE is concerned that if it were to regulate storage bin effectiveness in self-contained ice makers only, it could disincentivize the manufacturing and/or purchase of such equipment. Such an outcome would effectively eliminate a feature (built-in ice storage bins) that is currently available on the market, which would be in violation of EPCA. (42 U.S.C. 6295(o)(4))

Therefore, the Department agrees with commenters that storage bin effectiveness would be better addressed in a separate rulemaking. DOE requests further data to better assess the need for storage bin efficiency standards in the future. If standards for storage bins are to be set independently or incorporated into the existing metrics, DOE must first obtain data on the efficiency distribution and characteristics of storage bins and ice maker/bin pairings.

2.2.4.3 Ice Makers Intended for Supermarket Rack Connection

At the Framework public meeting, DOE asked whether a separate equipment class was needed for machines designed to be connected to remote compressor racks, and posed a question, largely oriented toward test procedures, about how best to account for the energy associated with the remote compressors and condensers.

Manitowoc commented that remote units designed for compressor rack connection are essentially the same ice-making head that is used with a dedicated remote condensing unit with some minor variations, but the efficiency of the ice-making head is essentially the same, whether the customer buys it to go with a dedicated condensing unit or to attach to a rack system. Manitowoc added that the decision is really driven by whether the customer is a new supermarket, where it is more cost-effective and energy efficient to install a rack-connected ice maker. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 154–155)

Scotsman added that the manufacturers do not know when they make the ice-making head what kind of compressor rack it will be connected to, and manufacturers cannot conduct an energy test because the system is not integrated with its compressors and condenser until field installation is complete. (Scotsman, Public Meeting Transcript, No. 13 at pp. 43–44)

Hoshizaki stated that ice makers designed for compressor rack connection should continue to only report the energy consumed by the ice-making head without including the energy use of the remote condenser or compressors, because the manufacturer cannot accurately determine what rack system the end user will utilize. Hoshizaki added that the need to test with any available rack system would put an undue burden on the manufacturer. (Hoshizaki, No. 18 at p. 2)

The Efficiency Advocates stated that, in the context of testing and reporting requirements for automatic commercial ice makers that are designed to be connected to a remote rack, they found Framework options 1 (default factor) and 2 (proxy condensing unit) preferable to option 3 (reporting the ice-making head energy usage only). The Efficiency Advocates further

commented that for either option 1 or 2, it is imperative that the "proxy" condensing unit or default condensing unit energy consumption not be less than that of the unit most likely to be selected by manufacturers. The Efficiency Advocates added that they do not support option 3, reporting the energy use of the ice-making head only, exclusive of the energy required for the compressors or the condenser, because this could mislead customers. The Efficiency Advocates did not express a strong preference between options 1 and 2, as long as the option chosen has energy use no less than a covered remote condensing unit of similar capacity. In other words, according to the Efficiency Advocates, the rating requirements for an ice maker designed for connection to a compressor rack system should be equivalent to those for other remote condensing options. (Efficiency Advocates, No. 15 at p. 5)

The Department elects to not address comments on this subject because the comments are rendered moot by the fact that the Department interprets equipment attached to supermarket racks to not meet the definition of an ice maker under EPCA. DOE understands that some high-capacity remote units are designed solely to be used with a remote condensing rack, and the commercial ice maker manufacturer does not manufacture (or purchase) condensers that could be paired with such ice-making heads. DOE notes that these units do not meet the statutory definition of an ice maker insofar as the definition states an ice maker "consists of a condensing unit and ice-making section operating as an integrated unit, with means for making and harvesting ice." (42 U.S.C. 6311(19)(A)) DOE preliminarily has determined that rack-only remote condensing units are not ice makers under the statute and should not be included in this rulemaking.

2.2.5 Prescriptive Standards for Adaptive Water Control

DOE's intention for the automatic commercial ice maker rulemaking is to establish performance standards. Under a performance standard, DOE establishes maximum allowable energy and, for water-cooled ice makers, maximum allowable condenser water usage. Manufacturers then select the mixture of technologies that allow them to produce the equipment their customers desire while still meeting the efficiency standards.

ACEEE asked for clarification regarding conflicting interpretations on DOE's authority to combine a prescriptive standard with a performance standard—for example, an energy performance standard in terms of kilowatt-hours per pound of ice coupled with an adaptive water use standard that respects the fact that water use must vary, depending on hardness of the water. (ACEEE, Public Meeting Transcript, No. 13 at pp. 101–102) ACEEE noted that the residential boiler standard now has a performance requirement in terms of annual fuel utilization efficiency and has an additional prescriptive requirement for a particular class of controls that increase the end use efficiency, but could not be addressed by the standard. ACEEE added that this was first negotiated, and then eventually accepted, by DOE. (ACEEE, Public Meeting Transcript, No. 13 at p. 103)

ACEEE encouraged DOE to look to manufacturers for the interplay between standards and the ability to market innovative features that have consumer value and have energy saving attributes, but may or may not be appropriate for standards. ACEEE added that this relates to features like adaptive controls and smart grid, and that ice makers would be amenable to grid

control to avoid use during particularly intensive peak load periods. (ACEEE, Public Meeting Transcript, No. 13 at p. 22)

The Efficiency Advocates commented on specific questions asked in the Framework document (items 3-11 through 3-14) regarding potable water use, indicating that the situation could be addressed with prescriptive requirements for adaptive purge or bleed controls based on turbidity or conductivity. (Efficiency Advocates, No. 15 at p. 6)

As stated earlier, DOE does not intend to set potable water standards. While some energy can be saved in some equipment by reducing potable water use, it is not clear that use of adaptive water control is a cost-effective way to save energy, because (1) it may actually increase water use in some circumstances; (2) the amount of energy savings associated with the water use reduction may be limited; and (3) sufficient data is not available to confirm that this approach is cost-effective. DOE requires representative field data regarding water use to properly evaluate adaptive water controls as an energy saving technology.

EPCA defines the term "energy conservation standard" as a performance standard that prescribes a minimum level of energy efficiency or a maximum quantity of energy use for a product or a design requirement for a product. (42 U.S.C. 6311(18)) EPCA clearly includes a "one or the other" definition. Therefore, unless other provisions of EPCA or other applicable law specifies otherwise, DOE must establish either a performance standard or design (prescriptive) requirements. In the case of commercial ice-making equipment, much of the equipment that is the subject of this rulemaking is currently covered by a statutorily mandated performance standard, and this rulemaking will ultimately result in performance standards for all commercial ice-making equipment with harvest rate capacities up to 4,000 lb/24 hours. Because DOE is currently considering performance standards for commercial ice-making equipment, DOE is precluded from implementing and is not considering design requirements.

2.2.6 Smart Grid Compatibility

The California IOUs and Sempra requested that DOE comment on the possible inclusion of smart technologies in these standards for automatic commercial ice makers, adding that these technologies are essential to successfully meet the challenges and goals associated with the sustainable smart grid and zero net energy in commercial buildings. The California IOUs and Sempra asked that, if DOE does not choose or is not able to include such a requirement, DOE comment on whether this will allow states the option to implement such requirements for these products. (California IOUs, No. 17 at p. 4; Sempra, No. 20 at p. 4)

As discussed in section 2.2.5, DOE may not establish both design and performance standards for automatic commercial ice makers. Requiring that ice makers have smart grid compatibility is essentially a design requirement. Hence, DOE cannot require such a feature.

The Department does not intend to evaluate demand control via smart technologies, leaving states the option of implementing such requirements. The Department's rulemaking authority makes frequent and specific reference to energy efficiency, energy savings, and energy consumption. The rulemaking authority does not specifically discuss demand reductions, demand controlling/shifting, or mitigating demand. The Department adheres to this direction in

rulemakings, and as a result, will not be examining ways in which smart technologies can be used with ice-making equipment to control demand.

2.3 MARKET AND TECHNOLOGY ASSESSMENT

When DOE begins an energy conservation standards rulemaking, it develops information that provides an overall picture of the market for the equipment considered, including the nature of the equipment, market characteristics, and industry structure. This activity consists of both quantitative and qualitative efforts based primarily on publicly available information. The market assessment examines manufacturers, trade associations, and the quantities and types of equipment sold and offered for sale.

DOE reviewed relevant literature and interviewed manufacturers to develop an overall picture of the automatic commercial ice-making equipment industry in the United States. Industry publications and trade journals, government agencies, and trade organizations provided the bulk of the information, including (1) manufacturers and their market shares; (2) shipments by product type and capacity; (3) product information; and (4) industry trends.

Subsequent sections of this chapter describe the comments DOE received in response to its review of the automatic commercial ice maker market for the Framework document. The analysis developed as part of the market and technology assessment is described in chapter 3 of the preliminary TSD.

2.3.1 Equipment Classes

Existing commercial ice maker equipment classes were enumerated in EPACT 2005 for cube ice makers, but, as noted above, several important equipment types did not have standards set by EPACT 2005. Rather, EPACT 2005 amended EPCA to grant DOE authority to set standards for other equipment types. (42 U.S.C. 6213(d)(2)) Potential additional equipment classes include automatic commercial ice makers that produce flake, nugget, tube, and other types of ice.

2.3.1.1 Criteria to Distinguish Equipment Classes

Requirements for establishing different equipment classes for most covered products are included in 42 U.S.C. 6295(q). While this section of EPCA applies to all consumer (*i.e.*, residential) products and commercial products specified in 42 U.S.C. 6316(a), neither of these provisions apply to automatic commercial ice makers. Nonetheless, DOE is considering defining equipment classes based on criteria that both affect energy use and represent distinct features that are valued by consumers, and also ensure that the energy standards will not lead to the disappearance of any currently existing equipment types, consistent with EPCA. (42 U.S.C. 6295(o)(4); 6313(d)(4); and 6295(q)) DOE is considering the following criteria to distinguish equipment classes: (1) ice-making process (*i.e.*, batch or continuous); (2) equipment configuration; (3) condenser cooling type (*i.e.*, air or water); and (4) whether the unit has a remote compressor. These class distinction criteria are described in further detail in the following sections and in chapter 3 of the preliminary TSD.

In the Framework document, DOE suggested a set of equipment classes (see Table 3.1 of the Framework document) and asked for comments from interested parties. At the Framework public meeting and in written comments, DOE received a wide range of input on how to establish equipment classes.

Equipment and Cooling Type

The major distinguishing characteristics of DOE's existing commercial ice-making equipment classes include type of equipment (ice-making head, self-contained unit, remote condensing and remote compressor, and remote condensing but not remote compressor), cooling type (water and air cooled[g]), and harvest capacity. Most interested parties approved of these sub-categories for equipment classes. Some interested parties provided additional clarification or input on these class-defining factors.

Note that extension of coverage in this rulemaking to other types of ice makers broadens the discussion of class-distinguishing characteristics to ice type. Ice type is discussed in the next section, while this section focuses on equipment type and cooling type, as described above.

The California IOUs and Sempra supported defining equipment classes according to (1) equipment type (ice-making head, self-contained, or with a remote condensing unit); (2) condenser cooling method (air or water); and (3) harvest capacity. (California IOUs, No. 17 at p. 2; Sempra, No. 20 at p. 2)

Scotsman supported the suggested sub-categories of air-cooled, water-cooled, remote (condenser only), and remote (condenser and compressor) condensing types. Scotsman did not support further sub-categorizing water-cooled units as once-through or pass-through cooling, chilled water loop systems, or evaporative cooling by the use of a cooling tower, because these are characteristics of the installation rather than the ice maker. (Scotsman, No. 22 at pp. 1–2)

The Efficiency Advocates stated that they expect to see increased interest in innovative systems that recycle heat (such as water loop systems) and systems that reject heat outdoors (remote condensers and rack systems), adding that this requires DOE to ensure that its standards do not inadvertently discourage products that would actually save energy or lead customers to believe that units with integrated air-cooled condensers that reject waste heat to the building's interior air are more efficient than systems that reduce heat rejection into cooled spaces. (Efficiency Advocates, No. 15 at p. 5)

Based on DOE's initial determination related to the equipment and cooling types, and the lack of objection from interested parties, DOE intends to use equipment type and cooling type as distinguishing criteria for equipment classes, as outlined in the Framework document. DOE intends to base its equipment classes on the same equipment and cooling type classifications

[g] Note that cooling type refers to the means for disposing of heat transferred by the refrigeration system to the condenser. Ice-making machines either release the heat directly into the air or release the heat into water in the condenser (*i.e.*, the so-called condenser water that is discussed in section 2.2.3). Condenser water is either disposed of directly into the wastewater system or transferred in a closed-loop system to a cooling tower or other secondary heat rejection component that usually releases this heat to the outside air.

initially established by EPACT 2005 solely for cube ice makers:

- ice-making head: air-cooled and water-cooled
- remote condensing unit: with and without a remote compressor
- self-contained unit: air-cooled and water-cooled

In response to the comments by the California IOUs and Sempra, harvest capacities are discussed further in section 2.3.1.2.

DOE agrees with Scotsman's recommendation against product class distinction by water loop type used in the installation, since DOE has no jurisdiction over installation of the equipment.

Type of Ice

As discussed in section 2.2.1, DOE expects to extend coverage beyond the currently covered cube ice makers so that the energy conservation standards apply to machines that make a range of ice types, including cube, tube, flake, nugget, chipped, and cracked ice. As discussed in sections 2.2.1.3 and 2.2.1.5, DOE expects to categorize all ice machines that use a batch process—including cube, tube, chipped, and cracked ice machines—together under standards for batch ice makers. The concept of continuous ice makers, which include both flake and nugget ice machines, was introduced in section 2.2.1.2.

As illustrated in Table 3.1 of the Framework document, DOE suggested development of three separate sets of standards for machines producing cube ice, flake ice, and nugget ice, and requested comments on the proposal to differentiate equipment classes by the type of ice produced using these three class distinctions.

Many interested parties recommended establishing ice types simply according to two categories, batch and continuous, rather than separating flake and nugget ice makers.

Manitowoc stated that a "cube type" category, which applies to any ice produced using a process employing alternating freeze and harvest sequences, and a "continuous type" category, which applies to ice produced using concurrent freeze and harvest of ice, can cover all known variants of commercial ice machines. (Manitowoc, No. 19 at p. 1) Manitowoc added that continuous and batch machines operate in fundamentally different ice production cycles and produce ice that is fundamentally different, and stated that flake and nugget ice are an aggregate of ice crystals and liquid water, and the fraction of the ice product that is frozen can be as low as 60 percent for flake to over 90 percent for nugget. Manitowoc further stated that harvest capacity for these machines is measured as weight of the product produced, but since the majority of the energy required in the production of the ice product involves phase change of water from liquid to solid (freezing), the quality (*i.e.*, fraction of solid ice, also known as hardness) of the ice product has a very significant and direct effect on the resulting energy use per pound of ice product. According to Manitowoc, important differences in end use of the ice product make it necessary to provide this wide range of quality, so it would not be acceptable to regulate the quality. Manitowoc recommended that, because the quality is measured as part of AHRI 810, DOE adopt an energy efficiency metric for continuous type machines that normalizes the input

energy per mass of ice produced with the quality to provide an equal basis for minimum energy efficiency for all continuous type machines regardless of the quality of ice produced. (Manitowoc, No. 19, p. 2)

Manitowoc also commented that continuous type ice and cube type ice are not substitutes—they have very different characteristics that lead to very different underlying technology and processes to produce the ice, and they need to be separated. (Manitowoc, Public Meeting Transcript, No. 13 at p. 49)

AHRI recommended that the "type of ice" category be divided into cube and continuous, where the continuous category would be composed of flake, nugget, and similar machines. AHRI added that cube and continuous type machines have very different characteristics that lead to very different technologies and processes to produce ice. (AHRI, No. 16 at p. 2)

Scotsman commented that continuous ice machines are fundamentally and significantly more energy and water efficient than batch type machines. Scotsman continued by stating that putting the two types into the same equipment classes will have a tremendous impact on the commercial ice machine market if the results are that: (a) the most efficient machines are continuous type and the least efficient will be batch type; (b) only flake and nugget machines will be efficient enough to pass the standards; and (c) ENERGY STAR® adopts the approach, leading to even relatively inefficient continuous machines earning ENERGY STAR status and few if any cube machines earning ENERGY STAR status. Scotsman added several additional points, such as many customers only buy machines listed as ENERGY STAR machines. (Scotsman, No. 22 at pp. 1–2) Note that these comments comparing efficiency of continuous and batch machines are most likely based on the energy use metrics in AHRI Standard 810-2007, which are not adjusted for ice hardness. The proposal in the test procedure notice of proposed rulemaking (NOPR) to use an energy use metric that is adjusted for ice hardness (see 76 FR at 18432 (April 4, 2011)) was published after receipt of all Framework phase comments.

Scotsman commented that there should be two separate sets of standards: one for batch and one for continuous type ice machines. (Scotsman, No. 22 at p. 4)

Hoshizaki requested that there be a batch category for cube and tube ice and a continuous category for flake and nugget ice because flake and nugget are very similar and do not need separate energy categories. Hoshizaki pointed out that AHRI has consolidated flake and nugget into a continuous ice machine category in its test standard. (Hoshizaki, No. 18 at p. 1)

However, other interested parties questioned the use of the ice-making process (*i.e.*, batch vs. continuous) as a basis for equipment class distinction.

The Efficiency Advocates stated that the primary factors in equipment classification should be those that the customer values most highly, adding that technology is secondary and should influence efficiency standard classes only to the extent that technology impacts utility. The Efficiency Advocates inferred that some customers value clear, hard ice (cube or tube ice), while others are satisfied with irregular, translucent forms (flake or nugget ice). The Efficiency Advocates concluded by stating that to the extent that this is true, they would prefer to see product classes based on a measurable utility discriminator (clarity and/or hardness) rather than

on process differences (batch vs. continuous production). The Efficiency Advocates stated that, alternatively, shape classification may better reflect customer values, with regular shapes like cylinders and cubes separated from irregular shapes like flakes. (Efficiency Advocates, No. 15 at p. 2)

During the Framework public meeting, ACEEE stated that distinguishing between batch and continuous is relevant only if the one of the types cannot substitute for the other based on the customer's perspective. (ACEEE, Public Meeting Transcript, No. 13 at p. 48)

The California IOUs and Sempra cautioned DOE about classifying ice makers by output or type of ice produced, recommending that DOE investigate the option of classifying equipment based solely on measurable consumer utility characteristics rather than on differences in ice production technology (*i.e.*, batch and continuous type units) as currently proposed. The commenters added that classifying equipment based on product utility would be consistent with past DOE energy conservation rulemakings and regulatory language. The California IOUs and Sempra did not believe that setting product classifications based on ice production technology offers any utility to the consumer. (California IOUs, No. 17 at p. 2; Sempra, No. 20 at p. 2)

Earthjustice commented that ice makers that produce cube ice can consume levels of energy and water that are comparable to flake and nugget machines. (Earthjustice, No. 14 at p. 2) Earthjustice commented that separate standards for different types of ice would likely have the effect of shielding some cube ice makers from the efficiency standards applicable to other types of machines. However, Earthjustice believed that, based on the information provided in the Framework document, it does not appear that any differences between cube and flake or nugget ice would justify such an outcome. (Earthjustice, No. 14 at p. 1)

Earthjustice stated that EPCA provides both mandatory and permissive authority for DOE to establish new product classes for covered products, per 42 U.S.C. 6295(o)(4), (q)(1); however, Earthjustice continued, aside from the unique situation of a covered product capable of consuming different kinds of energy, per 42 U.S.C. 6295(q)(1)(A), EPCA effectively mandates the creation of separate product classes only when the failure to do so would eliminate certain truly unique product attributes from the market, per 42 U.S.C. 6295(o)(4). Earthjustice stated that, in contrast, while DOE does have discretion to create separate classes for products based on the presence of "a capacity or other performance-related feature," the Department may exercise this authority only if "such feature justifies a [different] standard," per 42 U.S.C. 6295(q)(1)(B). (Earthjustice, No. 14 at pp. 1–2) In Earthjustice's view, dividing ice makers into separate classes based on the technology would ignore the statutory language that directs that any product class divisions be based on utility, *i.e.*, features provided to the end user. (Earthjustice, No. 14 at p. 3)

Earthjustice commented that, even assuming for the sake of argument that an attribute like low liquid water content would qualify as a "feature" within the meaning of 42 U.S.C. 6295(o)(4), it does not follow that EPCA requires separate product classes for ice makers that produce cube ice. Earthjustice stated that 42 U.S.C. 6295(o)(4) provides that those product features available after the effective date of a standard should be "substantially the same" as the features previously available. Earthjustice asserted that, in enacting this language, Congress was careful to note that the protection it offers to particular product attributes is narrow. (Earthjustice, No. 14 at p. 3)

Earthjustice added that the inclusion of this "substantially the same" language shows that Congress did not intend the resulting unavailability of any and every feature to be a barrier to the imposition of strong efficiency standards. Rather, Earthjustice asserted, EPCA only prohibits substantial adverse impacts on product utility, and because the performance of flake and nugget ice is substantially similar to the performance of cube ice, EPCA does not bar DOE's authority to group ice makers that produce different types of ice together under a single set of energy and water efficiency standards. (Earthjustice, No. 14 at p. 3)

Based on written comments and comments received at the Framework public meeting, DOE is proposing to consider utilizing batch and continuous as determining characteristics of equipment classes. The comments strongly indicate that the ice made by batch machines and continuous machines differs sufficiently from a customer utility perspective to allow such classification. There is sufficient evidence that the different utility aspects of the ice correlate very strongly with the ice-making process, batch or continuous, as indicated by much of the commentary. Hence, DOE intends to separate classes on this basis.

DOE will, however, also consider a single set of standards for batch and continuous machines if the analysis indicates that, with the hardness-adjusted energy use metric for continuous machines, a single set of standards is appropriate for the two ice maker types based on the criteria that DOE must use in selecting energy conservation standard levels. DOE intends to make final decisions on this issue after completing its analysis.

2.3.1.2 Harvest Capacity Break Points

In the Framework document, DOE indicated that for cube ice machines it intends to use the same harvest capacity break points that are currently specified in the EPACT 2005 standards. In the Framework document, DOE also suggested using these same harvest capacity break points between equipment classes for the flake and nugget machines. The subject of harvest capacity break points generated a considerable number of comments.

The Efficiency Advocates commented it would minimize market confusion to have the size classification breaks consistent across ice maker classes. (Efficiency Advocates, No. 15 at p. 4) The Efficiency Advocates also commented that size classes should reflect the most common groupings in the market, as influenced by application type, sales volume, or other factors. (Efficiency Advocates, No. 15 at p. 2)

The California IOUs and Sempra commented that DOE should use common harvest capacity groupings that are reflective of the market. The California IOUs and Sempra stated that DOE's proposed harvest capacity rate bins presented in the Framework document appear to be the same as those in the current Federal standards for batch type ice makers as prescribed by EPACT 2005 (42 U.S.C. 6313(d)(1)), and that it is unclear how these bins were initially determined. Therefore, the commenters suggested that DOE base the categorizations in this rulemaking on a comprehensive market survey and encouraged the Department to work closely with trade organizations, such as the Automatic Commercial Ice Makers and Ice Storage Bins Manufacturers Division of AHRI, and other manufacturers to determine how to classify these product groupings. The California IOUs and Sempra recommended that if the Department reclassifies batch type equipment by different harvest capacity groupings and proposes

associated amended standards for each group, DOE should ensure that amended standards meet EPCA's anti-backsliding provisions. (California IOUs, No. 17 at p. 3; Sempra, No. 20 at p. 3)

AHRI commented that the harvest capacity breakdowns (pounds of ice per 24 hours) and the corresponding energy use limits (kilowatt-hours per 100 lb of ice) were originally established based on product availability in the AHRI directory of certified commercial ice makers without taking into consideration shipment data. AHRI recommended that shipment-weighted "energy use limit" data be analyzed to properly establish the harvest capacity breakdowns. (AHRI, No. 16 at p. 2) AHRI did not believe that the representative sizes for ice cube machines properly reflect current market conditions. AHRI commented that it was collecting shipment information based on equipment harvest capacity and intended to make recommendations on the representative sizes in the near future. (AHRI, No. 16 at p. 4)

Manitowoc recommended that the harvest capacity intervals and representative sizes for each harvest capacity interval be reevaluated using aggregate industry volume data supplied by AHRI. Manitowoc stated that the decision on whether continuous type machines can have fewer intervals and representative sizes should be based on the range of commercially available models. (Manitowoc, No. 19 at p. 3)

Scotsman commented that the representative sizes proposed in the Framework document are wrong, and the number of groups is wrong as well. (Scotsman, No. 22 at p. 8) Scotsman commented that the harvest capacity break points should change as needed to properly create the energy use standards for each class of equipment. (Scotsman, No. 22 at p. 4) Scotsman also commented that the harvest capacity break points do not, and were never intended to, reflect the current market, and instead are a result of the equations that are used to define the energy use limits originally developed for the California Energy Commission (CEC) and DOE ice machine standards. As an example, Scotsman stated that if it had been possible to draw a single line that would represent the energy use limits for all air-cooled ice-making head machines, then there would be no "breakdown" at 450 lb per day or at any other production level. Scotsman further commented that, stated differently, the "breakdown" levels resulted from the math, not the market. Scotsman stated that different "breakdowns" or inflection points will likely be needed if different data are used, for example, if the data for flake or nugget ice machines are used. (Scotsman, Public Meeting Transcript, No. 13 at pp. 3–4) Scotsman also commented that the groups only applied to data at that time, and do not necessarily apply to today's data. (Scotsman, Public Meeting Transcript, No. 13 at pp. 42–43) Scotsman added that in the case of water, the analysis includes three lines, and the standards were set where the three lines each cross. Therefore, in Scotsman's view, the results do not reflect the market or other types of machines. (Scotsman, Public Meeting Transcript, No. 13 at p. 42)

Scotsman also stated that the CEC's process was to plot the machines to be regulated, capacities across the bottom, energy efficiency on the vertical axis, and then to draw a line such that, at that point in time, they were splitting it where only 20 percent of the machines would pass. So, the comment stated, one would draw a line, if that is the criteria, so that 20 percent of the machines are below the line, 80 percent are above, for example. (Scotsman, Public Meeting Transcript, No. 13 at p. 44)

DOE notes that it has collected data on available ice machines from various sources—this information is described in greater detail in chapter 3 of the preliminary TSD.

In addition, AHRI has submitted data addressing some of these issues, which includes the following.

1. Shipment-weighted energy use, potable water use, and condenser water use for all batch type ice makers segregated into 16 capacity ranges.

2. Shipment-weighted energy use, potable water use, and condenser water use for all continuous type ice makers segregated into 4 capacity ranges.

3. An updated version of 1 and 2 in which the data of each bin are separated to provide separate shipment-weighted data for air-cooled and water-cooled machines.

4. Shipment data for ice makers segregated by ice maker type (ice-making head, self-contained unit, remote condensing unit without remote compressor, remote condensing unit with remote compressor), condenser cooling type (air or water), and capacity range (the number of capacity ranges depends on the other characteristics). The data also include the number of shipments for each of these categories that qualify for ENERGY STAR.

While this information is very helpful to DOE in analyzing energy conservation standards for ice makers, it is not sufficient to allow the detailed process suggested by interested parties for establishing harvest capacity break points. The data do not include "energy use limit" information as suggested by AHRI. Further, they cannot be used to set efficiency levels based on 20 percent of the machines, as suggested by Scotsman. The data represented by number 4 above could possibly be used to set efficiency levels achieved by 50 percent of shipments. However, the data are not separated by ice machine type (ice-making head, remote condensing unit, self-contained unit), and the data are only split into four harvest capacity ranges for the continuous machines. AHRI did not, with submission of its data, provide recommendations regarding harvest capacity break points, as its initial comments suggested it might. Further, other interested parties such as Scotsman and the Efficiency Advocates, who commented or implied that the harvest capacity breakpoints should be reflective of the market, also did not indicate what break points might be more reflective of the market than the current values for cube ice makers. In any case, the data collected by DOE and the data provided by AHRI mostly support the harvest capacity break points initially established for the CEC rulemaking and mandated for DOE by EPACT 2005. DOE has developed a different set of break points for some of the continuous ice maker classes. This is discussed in greater detail in the chapter 5 of the preliminary TSD. Chapter 5 also discusses development of harvest capacity break points and efficiency levels for the preliminary analysis. DOE requests comments on its preliminary selection for these parameters—see the preliminary TSD executive summary.

2.3.2 Technology Assessment

As part of the market and technology assessment, DOE developed a list of technologies to consider for improving the efficiency of automatic commercial ice-making equipment.

Chapter 3 of the preliminary TSD includes the detailed list of all technology options DOE identified for further consideration in this rulemaking.

During the Framework public meeting, DOE requested comment regarding the technology options that it had listed in the Framework document. While some of this discussion addressed whether a particular technology should be screened out during the screening analysis, all of the discussion associated with the merits of specific technologies has been consolidated in this section for consistency.

2.3.2.1 Reduction of Potable Water Use

As discussed in section 2.2.2.1, DOE is not likely to regulate potable water use of ice makers in the rulemaking. Hence, potable water use reduction is discussed primarily in the context of its corresponding impact on energy use.

With respect to the relationship between energy usage and water usage, Scotsman commented that in most cube ice machines the amount of water used for ice making is related to energy efficiency. However, Scotsman added, there are practical limits to how far potable water usage in a batch type ice machine can be reduced. Scotsman stated that if the potable water use is reduced below approximately 18 gal/100 lb, the ice machine will very likely fail due to impurities collecting in the ice machine. Scotsman asserted that the impurities precipitate out of the ice-making water if they are not flushed out sufficiently, and the only way to reduce this without negatively impacting machine reliability is with water treatment prior to ice making. (Scotsman, No. 22 at p. 5)

Manitowoc agreed that efforts to improve efficiency would tend to reduce potable water use for batch machines, adding that these comments specifically address batch ice machines, because water use and ice product output are essentially equal for continuous ice machines. Manitowoc commented that there is actually an optimum potable water use level, and reducing potable water excessively creates reliability issues. As water use is reduced further, Manitowoc stated, the amount of scale that is deposited on the evaporator of the ice machine increases, and it actually hurts efficiency because of the added heat transfer resistance, and also because the scale will slow down the harvest part of the cycle, leading to more ice meltage. Manitowoc stated that manufacturers have to deal with a wide range of water quality issues throughout the country—each machine must be able to handle all but the very worst quality water—and this limits how far manufacturers can go in reducing water use. Manitowoc added that there may be more opportunity for water use reduction using adaptive controls, but without considering such approaches, the current water use levels are very close to the optimum point. Manitowoc further cautioned DOE to address this issue properly in the analysis, since the total dissolved solids in the water and the potential for minerals coming out of solution drive many design decisions. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 93–95)

DOE requests comments from all interested parties on the minimum potable water rates that can be expected for batch ice makers, and data to support such comments (see the preliminary TSD executive summary).

Scotsman commented that it is possible to put heat recovery devices on the ice machine to extract the lost "cooling" before the purge water is allowed to go down the drain. Scotsman stated that, in this way, a machine with a very efficient heat recovery system could use a lot of water and yet be very energy efficient. (Scotsman, No. 22 at p. 5)

DOE did not include drain water thermal energy exchange in its analysis because of space constraints in the ice machine and questions about whether external heat exchangers could be considered part of the ice maker (see the discussion in chapter 4 of the preliminary TSD). Drain water must flow via gravity to the drain outlet. Generally, the flow is from the pump discharge, allowing some vertical height for such flow within the existing height envelope of typical ice machines. However, the space for insertion of a drain water heat exchanger is limited, and doing so in most cases would require increasing the size of the ice maker. See the related discussion of size increase in section 2.3.2.5. DOE may reconsider this option for the NOPR analysis, provided appropriate examples of thermal exchange technology can be identified.

2.3.2.2 Condenser Water Use

As discussed in section 2.2.2.2, DOE intends to adopt and/or modify condenser water regulations only in the context of avoiding excess water waste associated with a significant increase in condenser water use for the purpose of complying with energy usage limits. Hence, discussion of technology options to reduce condenser water use is somewhat irrelevant. Also, DOE has concluded that consideration of an increase in maximum allowable condenser water consumption is allowable if it can cost-effectively reduce energy use. Hence, DOE is considering an increase in condenser water use as a technology option to reduce energy use. Several of the comments provided by interested parties regarding condenser water use are summarized in section 2.2.2.2.

Scotsman commented that the condenser water used in water-cooled ice machines can be reduced through several options: using larger, more efficient condensers; installing the ice maker on a closed-loop water system;[h] or using an air-cooled machine instead. (Scotsman, No. 22 at p. 5)

As mentioned above, DOE's analysis of condenser water usage will consider cost-effective selection of condenser water flow balanced with energy use impacts. DOE did not incorporate the use of larger, more efficient condensers for water-cooled ice makers in its preliminary analysis, but will consider this option for subsequent analysis. Regarding installation of ice makers on closed-loop water systems, DOE does not have authority to regulate the field use of equipment. Also, EPCA does not allow DOE to establish a requirement that water-cooled ice makers separate the potable and condenser water flow paths through the ice machines so that all water-cooled machines can be used in closed-loop applications. EPCA allows DOE to establish either a performance standard or a design standard, but not both for the same

[h] A closed-loop system uses water to transfer condenser heat to another location, recirculating the water in a closed loop. This is in contrast to open-loop systems, in which water is disposed of in a building's drainage pipe system after passing once through the ice maker's condenser. Hence water consumption is much lower for closed-loop systems. Water use may be non-zero because many closed-loop systems cool the water using cooling towers, which use evaporation of some of the water to enhance its cooling.

equipment. (42 U.S.C. 6311(18)) Finally, DOE notes that the choice to purchase an air-cooled rather than water-cooled ice maker is up to the end user—however, DOE does not intend to develop regulations that would eliminate the availability of water-cooled ice makers.

DOE will consider in the NOPR analyses the use of larger condensers to allow reduction in condenser water flow. Such a design option may be considered as a means to reduce energy use, rather than as a means specifically to reduce condenser water use, which, as discussed in section 2.2.2.2, is not being considered in this rulemaking. Because of the relationship of condenser water use and energy use, the cost of condenser water use must be considered in evaluating the cost-effectiveness of design options to reduce energy use. If a design option indirectly allows consideration of higher energy efficiency by reducing the operating cost associated with condenser water use, it can indirectly contribute to energy efficiency. This is discussed in more detail in section 2.5, in the discussion of the engineering analysis.

2.3.2.3 "Smart" Technologies

The Efficiency Advocates stated that adaptive controls and modulating compressors could save substantial energy in many ice maker categories, and added that this may also be true for condenser fan motors. The Efficiency Advocates further commented that, as loads go down, modulating the compressor gives a relative increase to the heat exchangers' areas, which should improve efficiency—all other things being equal. The Efficiency Advocates added that the "smarts" required are certainly available, requiring little beyond the interval durations in which the equipment is calling for an ice-making cycle. (Efficiency Advocates, No. 15 at p. 5)

The California IOUs and Sempra supported comments submitted by ACEEE that DOE should consider newer technologies available in the market for ice makers, such as adaptive controls and modulating compressors that can improve efficiency and save significant amounts of energy. (California IOUs, No. 17 at p. 2; Sempra, No. 20 at p. 2)

DOE acknowledges that modulation and adaptive water controls may save energy. DOE proposed an energy use metric that accounts for capacity modulation in the test procedure NOPR. 76 FR at 18434 (April 4, 2011). However, interested parties commented that modulation should not be included in the energy use metric. (See, for example, Docket for Test Procedures for Automatic Commercial Ice Makers, Docket No. EERE-2010-BT-TP-0036; AHRI, No. 15 at pp. 3–4; NRDC, No. 12 at p. 1.) If DOE does not incorporate modulation in the energy use metric, there is no basis on which to distinguish the potential energy saving features of modulating equipment. Further, technical feasibility is not established for this technology option, because DOE cannot cite examples of products or prototypes employing modulation—either such products and prototypes do not exist or information about them is not publicly available. Hence, it cannot be considered for the engineering analysis.

DOE also notes that the test procedure does not measure the benefits of adaptive water controls; thus, DOE has no basis on which to distinguish the potential energy savings of this feature. Measuring this benefit requires testing with standard water hardness, a revision that was considered for the test procedure but was not implemented because data are not available to confirm that such a test would be reliable and repeatable. 76 FR at 18437 (April 4, 2011).

2.3.2.4 Insulation

Manitowoc recommended that DOE not spend a lot of time evaluating insulation, stating that while insulation has some impact on energy, it is mandatory for preventing water condensation on chilled surfaces for safety, sanitary, and aesthetic reasons (at a level where any increase in insulation levels offers no measurable improvement). (Manitowoc, No. 19 at p. 2) AHRI agreed that insulation has little to do with energy consumption and more to do with the prevention of sweating, and that DOE should not spend a lot of time assessing the energy benefit of additional insulation because the benefits are negligible. (AHRI, No. 16 at p. 3)

DOE has not used insulation as a design option in its preliminary analysis, as it agrees that the energy efficiency benefit of additional insulation generally is small.

2.3.2.5 Technology Options Requiring Equipment Size Increase

Manitowoc commented that physical size of ice makers is very important, even for machines with higher harvest capacities. According to Manitowoc, there generally is limited space available in the establishments using ice makers—for example, restaurants, hotels, and casinos, and the size of the machine is strongly related to both efficiency and cost. (Manitowoc, Public Meeting Transcript, No. 13 at p. 50)

Because the Department recognizes that ice-making equipment is frequently placed in a pre-specified and limited space within a given building, the Department focused during the preliminary analysis on efficiency improvements that would not increase size. However, DOE recognizes that for some equipment types and harvest capacities, the maximum technology level determined in the engineering analysis represents greater energy use than some available products on the market. In most of these cases, these higher efficiency products are physically larger than the analyzed equipment. Decisions regarding target product size are complex. Rather than maintain the fixed-size approach for the NOPR phase, DOE may consider an increase in equipment size as it refines its analyses. To that end, DOE requests comment on whether a size increase should be considered in the analysis refinements, and, if so, how DOE should determine the allowable size increase (see the preliminary TSD executive summary).

2.3.2.6 General Technology Comments

AHRI commented that the design options identified in the Framework document are not meaningful as individual improvements because systems' efficiency gains are usually the result of combining several technology options. AHRI also stressed that the energy efficiency benefits, if any, of combinations of these design options are not simply additive. AHRI stated that assessment of the combined benefit of multiple design options requires a rigorous analysis and simulation of the total system in which they are employed. (AHRI, No. 16 at p. 3)

Manitowoc commented that basic design variables of compressor efficiency, heat exchanger design, motor and fan efficiency, and expansion device should be the focus for analysis of achievable efficiency levels and the associated manufacturing cost. (Manitowoc, No. 19 at p. 3)

Scotsman commented that permanent split capacitor and electronically commutated fan motors can be combined into a single category called "higher efficiency fan motors". (Scotsman, No. 22 at p. 4)

Scotsman also recommended renaming one design option as "design options which reduce harvest meltage and/or accelerate the harvest process." (Scotsman, No. 22 at p. 4) Scotsman commented that (technology and design options) number 6 should be modified to read, "design options which reduce energy loss due to thermal cycling." (Scotsman, No. 22 at p. 4)

Referring to the Framework document, Manitowoc commented that design options that address melting during harvest and thermal cycling of the evaporator constitute "an end," and unless specific technologies that achieve that end can be identified, it is difficult to do the engineering analysis. Manitowoc pointed out that, for instance, reducing meltage from 10 percent to 3 percent would improve the energy efficiency, but if specifying such a reduction does not indicate what causes the reduction, this makes engineering analysis difficult. Manitowoc commented that this could be contrasted with the case of a condenser or a fan and a broad class of components surrounded by engineering principles indicating how one would improve the component's efficiency. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 79–80) Manitowoc added that design options to reduce harvest melt and to reduce thermal cycling of the evaporator are in most cases proprietary, specific to the design of the evaporator (making it nearly impossible for DOE to quantify in a generalized analysis, and very difficult if not impossible to accurately model). For these reasons, Manitowoc recommended that DOE remove these design options from its analysis. (Manitowoc, No. 19 at p. 2)

Scotsman commented that tube machines are batch machines, and stated that some technology options applicable to tube machines were not shown as applicable in the Framework document, including drain water thermal exchange and "less potable water flow." Scotsman stated that tube machines are essentially the same as a cube ice machine and the same technology changes should apply. Scotsman asserted that they work the same way as batch machines, although they sometimes use upstream technologies like a reverse osmosis system so that they can use 100 percent of the water; but fundamentally, it's the same process. (Scotsman, Public Meeting Transcript, No. 13 at p. 82)

DOE has for the most part not incorporated in the preliminary analysis design options that reduce meltage or thermal cycling, but requests better clarification regarding what design options exist that address these issues, and whether such design options are proprietary or generally available technologies (see the preliminary TSD executive summary; see also section 2.5.6 regarding consideration of proprietary designs in the engineering analysis).

DOE has conducted a rigorous analysis that does not simply add the benefits of each individual design option. DOE notes that all design options recommended by Manitowoc to be included in the analysis have been considered. DOE has considered higher efficiency motor options, whether they be permanent split capacitor or electronically commutated motor. DOE does not object to using the design option names suggested by Scotsman: "design options which reduce harvest meltage and/or accelerate the harvest process" and "design options which reduce energy loss due to thermal cycling." However, these options are subject to the consideration of whether they represent proprietary designs, as discussed above.

As suggested by Scotsman, DOE will consider drain water thermal exchange and reduced potable water flow as relevant technology options for tube ice makers.

2.4 SCREENING ANALYSIS

The purpose of the screening analysis is to evaluate the technologies identified in the technology assessment to determine which options to consider further in the engineering analysis. As stated above, DOE considers those technologies for which energy impacts can be measured using the DOE test procedure, and DOE proposed test procedure amendments to measure the impacts of additional technologies in a separate rulemaking. DOE also removes technologies that do not change or affect the energy efficiency of commercial ice-making equipment. In the screening analysis, DOE then examines whether the remaining technologies (1) are technologically feasible; (2) are practicable to manufacture, install, and service; (3) have an adverse impact on product utility or availability; and (4) have adverse impacts on health and safety. DOE reviewed the list of technologies according to these criteria in consultation with industry, technical experts, and other interested parties. In the engineering analysis, DOE further considers the energy saving technologies that it did not eliminate in the screening analysis. Chapter 4 of the preliminary TSD, the screening analysis, contains details about DOE's screening criteria.

ACEEE suggested that technological feasibility would be demonstrated if a particular technology option is in use anywhere in the world in a mass production environment, and not just in the United States. (ACEEE, Public Meeting Transcript, No. 13 at p. 98)

DOE's research reveals no evidence that technologies are being used in ice makers of similar categories in international markets that are not being used in U.S. ice makers.

2.5 ENGINEERING ANALYSIS

The purpose of the engineering analysis is to determine the relationship between manufacturer production cost (MPC) and energy and/or water consumption for automatic commercial ice makers. In determining this relationship, DOE will estimate the increase in MPC associated with design changes that decrease energy consumption as compared with baseline-efficiency models. DOE recognizes that some design options will reduce both energy and water consumption, but others may reduce one and increase the other. DOE will make simplifying assumptions as appropriate to reduce the potential complexity of analyses that would fully evaluate the trade-off in benefits associated with water conservation versus energy conservation.

DOE will develop cost estimates for the engineering analysis disaggregated into the cost contributions of materials (including purchased parts), labor, and overhead. This information will be used in all of the downstream analyses, including the manufacturer impact analysis (MIA). DOE will create an industry-wide analysis based on a variety of data sources, including manufacturer-supplied data.

In addition, DOE must identify the model with the lowest energy consumption that is technologically feasible within each equipment class (*i.e.*, the "max-tech" model). While this rulemaking also addresses condenser water consumption, as discussed in section 2.2.2.2, the regulation of condenser water use for ice makers is intended primarily to prevent excess water

waste associated with attempts to reduce energy use by increasing condenser water use. Hence, the engineering analysis does not identify maximum technology levels for condenser water consumption.

2.5.1 Analysis Approach

DOE has developed three basic approaches to the engineering analysis: design-option, efficiency-level, and reverse-engineering/cost-assessment.

A design-option approach uses individual design options, or combinations of design options, to identify increases in efficiency. Under this approach, cost estimates are based on manufacturer or component supplier data or engineering computer simulation models. Individual design options, or combinations of design options, are added to the baseline model in ascending order of cost-effectiveness. Also, the efficiency levels addressed in the analyses, including the downstream analyses, are based on groups of design options.

An efficiency-level approach establishes the relationship between manufacturer cost and increased efficiency at predetermined efficiency levels above the baseline. Under this approach, manufacturers typically provide manufacturer cost data for incremental increases in efficiency, without identifying the technology or design options they would use to achieve such increases.

A reverse-engineering or cost-assessment approach involves purchasing representative units of automatic commercial ice-making equipment, disassembling the units, and reverse engineering the manufacturing costs based on a "bottoms-up" manufacturing cost assessment. The efficiency levels addressed in the analyses for such an approach are based on the efficiency levels of the reverse-engineered products.

DOE plans to use a combination of all three of these approaches to determine the cost-efficiency relationship for this rulemaking. This approach will seek to obtain information from a variety of sources, including consultation with outside experts, review of publicly available cost and performance information, modeling of equipment cost and energy consumption, interviews with manufacturers, product teardowns and reverse engineering, and data submissions provided by the industry. DOE expects that efficiency levels addressed in the analyses will be associated, to the extent possible, with existing voluntary programs for efficiency improvement, such as ENERGY STAR or Consortium for Energy Efficiency (CEE), to simplify comparison of engineering analyses with products currently on the market meeting these voluntary program requirements.

The Efficiency Advocates stated that they had no *a priori* objections to using some combination of design-option, efficiency-level, and reverse-engineering approaches to learning about the cost of efficiency. (Efficiency Advocates, No. 15 at p. 4)

AHRI commented that the use of a design option approach to determine the relationship between manufacturer selling price (MSP) and energy consumption, although not perfect, is acceptable. However, AHRI does not intend to provide cost-efficiency curves to DOE. Instead, AHRI commented that these curves should be developed by DOE and validated against actual retail sales prices. In AHRI's view, focusing on retail sale prices instead of attempting to build

up from estimates of manufacturer costs and the several markups in the supply chain to the end user will improve the accuracy of the analysis. (AHRI, No. 16 at p. 4)

DOE will attempt to correlate efficiency levels with sales price. However, sales price variations are associated with many factors, including, but not limited to, ice characteristics, specific product features, and vendor/buyer relationship, to name a few, and not just efficiency levels. Further, there are often product availability gaps at specific efficiency levels that may be viable. The correlation of actual sales price and list price may not be consistent between different models. Finally, while sales price variation as a function of efficiency level may provide an indication of the cost of improved efficiency in the current market, it doesn't necessarily provide an accurate indication of the increase in cost of baseline equipment in the case of a change in energy standards.

2.5.2 Balancing Energy Use and Condenser Water Use in the Analysis

DOE highlighted in the Framework public meeting the challenges of conducting an engineering analysis in which consumption of energy can be reduced by increasing condenser water use. DOE requested comments on this issue, specifically asking whether any simplifying assumptions may be applied to reduce the complexity of the analysis.

Manitowoc commented that the dynamic nature of the batch ice-making cycle and the multiple aspects of physics involved, including heat transfer, phase change, surface tension, and the influence of controls and sensors, does not lend itself to simplifying assumptions. Manitowoc stated that ice machine design is still largely experimental due to the difficulty associated with modeling a transient phase change event coupled with a vapor compression cycle. (Manitowoc, No. 19 at p. 3) Manitowoc commented during the Framework public meeting that there are many complexities and compounding effects that go into managing water use and how the machine operates, and while DOE might be looking for a "nice, simple model," Manitowoc stated that they could not offer one. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 104–105)

Scotsman supported DOE's direction regarding use of simplifying assumptions to avoid excess complexity in analysis of design changes that affect both energy and water use. (Scotsman, No. 22 at p. 6) However, Scotsman did not provide specific guidance regarding such simplification of the analysis.

DOE has developed an approach for balancing energy use and condenser water use in the engineering analysis in a way that maintains the rulemaking's focus on energy use reduction while appropriately considering the cost implications of changing condenser water use. This analysis would use appropriate representative values for water and energy costs, product lifetime, and discount rates to allow calculation of representative life-cycle cost (LCC) for baseline and modified design configurations. The engineering analysis would develop a relationship between energy efficiency and manufacturing cost as is customarily done in engineering analyses (*i.e.*, the cost-efficiency curves), but the ordering of different design configurations in this curve would be based on minimizing the representative LCC calculated for the candidate design configurations at each successive efficiency level. Increase in condenser water use to reduce energy use is expected to be cost-effective when the next design option that does not change water use becomes costly enough that allowing a condenser water use increase instead is more cost-

effective. This approach avoids the complexity of developing multiple cost curves representing multiple condenser water use levels and determining in the downstream analyses when to consider increasing condenser water use.

DOE also will consider using this approach to select the condenser water use standards for continuous ice makers. The cost-efficiency curves developed by the engineering analysis would consider, based on the minimization of representative LCC, at what efficiency levels it is cost-effective to increase condenser water use. In this way, the candidate standard levels considered for selection of energy standards will have already embedded in them the appropriate cost-effective condenser water use levels based on consideration of representative LCC.

DOE has not yet implemented this approach in the preliminary analysis, but intends to do so as the analysis is refined in the NOPR stage. DOE requests comment on this approach for balancing the impacts of condenser water use and energy use without making the analysis unnecessarily complicated (see the preliminary TSD executive summary).

2.5.3 Efficiency Levels

2.5.3.1 Baseline Efficiency

DOE indicated in the Framework document that the baseline efficiency levels for equipment currently covered by the DOE standards will be the current maximum energy use levels. DOE did not receive any comments opposing this approach.

The current standards do not cover continuous ice makers. DOE presented in the Framework public meeting two options for developing efficiency levels for these products: (1) use of Canadian standards; and (2) development of baseline efficiency levels consisting of two-part curves based on test data. DOE requested comments on these options for development of continuous ice machine efficiency levels.

Hoshizaki supported the second option for continuous ice machines, the use of a two-part curve based on best fit for equipment data, indicating that a thorough look at the current market will be beneficial in the development of energy standards. (Hoshizaki, No. 18 at p. 2)

With respect to Hoshizaki's comment, for the preliminary analysis DOE has chosen continuous machine baselines at sufficiently high energy use levels that they exclude almost no products. DOE could consider setting baselines instead at average levels as a function of capacity, using a two-piece linear approach. However, this requires that data be made available consistent with the test procedure NOPR energy use metric for continuous machines, incorporating an adjustment based on ice quality. At the time this TSD was drafted, continuous ice maker data was not yet posted on the AHRI website. Hence, this level of aggregation of data was not available in time to support development of the preliminary analyses. DOE will review the AHRI data when it is available and consider potential alternative baseline efficiency levels, using the data as input. However, the AHRI data does not reflect shipment levels and may still not meet all desired criteria for establishing efficiency levels. DOE encourages AHRI and the industry to consider what it can do to support additional data collection and submission to allow DOE to achieve the multiple goals of all commenters regarding the selection of equipment classes and efficiency levels.

Manitowoc commented that DOE should find a way to develop efficiency levels and harvest capacity break points consistent with the CEE tiers and break points. Manitowoc pointed out that CEE, through their utility member companies, provides rebates that are important to them and drive decisions that Manitowoc makes on design changes to their ice machines. Manitowoc stated that they would like a standard approach for regulations with ENERGY STAR and DOE minimum standards, and also would like harmonization between CEE and the Federal regulations. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 74–75)

The Efficiency Advocates expressed appreciation for the effort that has gone into the proposed efficiency levels, particularly the effort to examine work by others (Natural Resources Canada (NRCan), etc.). The Efficiency Advocates added that the selected levels appear to be reasonable. (Efficiency Advocates, No. 15 at p. 6)

AHRI commented that NRCan's standard-setting process does not subject potential standards to the same range of analyses that DOE standards go through, implying that efficiency levels based on the NRCan standards may not be appropriate. (AHRI, Public Meeting Transcript, No. 13 at p. 130)

The Efficiency Advocates encouraged the Department to draw lessons from retrospective studies regarding the observed impact of standards on the market (with controls for short-run impacts such as commodity price excursions). (Efficiency Advocates, No. 15 at p. 4) DOE notes that it has not retained selection of the NRCan standard for any of the continuous ice machine baseline efficiency levels. DOE has, however, set harvest capacity break points for some continuous machine equipment classes at the levels set by CEE for Tier 2 flake ice makers, consistent with Manitowoc's recommendation.

In response to the comment from the Efficiency Advocates, DOE will consider the trend for real product cost to decline as a function of cumulative production over time. DOE considers this price impact as part of the national impact analysis (NIA).

2.5.3.2 Maximum Technology

Interested parties made few comments regarding maximum technology levels.

ACEEE commented that it is extremely important that the Department base its analysis of maximum technology on an international baseline, and not just common practice in the United States. ACEEE stated that for the industry to be competitive, to be leaders, to remain competitive, and to protect jobs and investment, there must be an understanding of what the state-of-the-art is internationally. (ACEEE, Public Meeting Transcript, No. 13 at p. 21)

The Efficiency Advocates stated that max-tech in the global market today and the efficiency standards and technology content that define state-of-the-art are key for understanding both the amount of energy that could be saved and the environment in which U.S. manufacturers will compete in the period covered by these standards. (Efficiency Advocates, No. 15 at p. 1)

DOE has investigated efficiency levels for ice makers produced outside the United States but has not been able to verify that any such ice makers achieve efficiency levels significantly

higher than those of ice makers sold in the United States. DOE welcomes any such information that can be identified.

2.5.4 Selection of Products for Testing and Reverse Engineering

DOE presented at the Framework public meeting a list of ice makers intended for purchase for energy testing and reverse engineering and requested comment on the product selections and whether they are representative of the market.

Manitowoc commented that they would recommend a few additional models. (Manitowoc, Public Meeting Transcript, No. 13 at p. 122) However, Manitowoc did not provide specific guidance for making such additional selections in their written comments.

Scotsman asked whether the reverse engineering list included any products that include ice making, storage, and dispensing. (Scotsman, Public Meeting Transcript, No. 13 at p. 117)

Scotsman commented that flake and nugget machines can be represented by fewer representative products than cube machines. (Scotsman, No. 22 at p. 8)

One of the products selected for reverse engineering does include storage and dispensing as well as ice making. Also, DOE has selected for teardown and in-depth analysis fewer continuous products than batch products, as suggested by Scotsman. See chapter 5 of the preliminary TSD for details regarding the list of ice makers used for reverse engineering and energy testing for the preliminary analysis.

DOE also notes that it received data from AHRI, but that this data was received too late to affect selection of units for teardown and detailed analysis during the preliminary phase. DOE acknowledges that the shipment data suggest that a better representation of the market may have been achieved if DOE's equipment selections had focused more on lower capacity machines.

2.5.5 Industry Data Collection

DOE mentioned during the Framework public meeting that it might ask manufacturers to participate in an effort to collect cost-efficiency data, as has been done in past rulemakings. Such data is generally aggregated prior to submission to DOE, generally by a trade organization such as AHRI.

AHRI commented that they have, in the past, collected and aggregated cost-efficiency data for DOE, but that the process required a lot of effort and was challenged by many as being done through a "black box," since nobody knew the details of what made up the final results. AHRI stated that it has therefore moved away from that process and does not want to go through such an effort if the information will not be used by DOE. (AHRI, Public Meeting Transcript, No. 13 at pp. 108–109)

ACEEE commented that they look to AHRI as a very important source of data supporting market segmentation and development of equipment classes. ACEEE expressed hope that AHRI would do some of its own analysis, because it is good to have independent estimates from AHRI and DOE. (ACEEE, Public Meeting Transcript, No. 13 at pp. 109–110)

DOE understands AHRI's reluctance to expend significant effort if the results of that effort are not ultimately used in determination of energy standards. DOE welcomes any constructive comments that AHRI can provide to ensure the best accuracy in the analyses.

2.5.6 Proprietary Designs

AHRI commented that DOE should limit its analysis to technologies available to all manufacturers in the industry, and stated that proprietary designs and technologies should not be considered in this rulemaking. (AHRI, No. 19 at p. 4) AHRI also commented that if a design is proprietary, others will not be able to use it, so proprietary designs cannot be considered to establish a standard. (AHRI, Public Meeting Transcript, No. 13 at p. 132)

Manitowoc commented that they could help answer questions about whether a particular design feature is proprietary, in other words, whether there is intellectual property around it. Manitowoc stated that the manufacturers tend to keep track of who has patents on what, and it may be helpful to provide indication whether any particular feature seen in a reverse engineering unit is something available to only one manufacturer. Manitowoc commented that such discussion may also address whether there are alternative technologies or approaches that could be used to obtain the same end result or same net impact. In some cases, according to Manitowoc, the answer is yes, in other cases, it may be no. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 134–135)

Consideration of efficiency levels that can be attained by proprietary designs can be included in the analysis, if alternative design options can be used to attain the same levels. DOE has not considered proprietary designs in its preliminary analysis. DOE requests comment on specific aspects of ice maker evaporator design that may be proprietary (see the preliminary TSD executive summary).

2.5.7 Refrigerants

ACEEE raised the issue of alternative refrigerants, commenting that evolution of refrigeration system architectures may be required by the next round of refrigerant replacements for environmental concerns. (ACEEE, Public Meeting Transcript, No. 13 at p. 155)

AHRI urged DOE to fully consider the impact of various climate change bills being debated in Congress. AHRI stated that, depending on which versions prevail, these bills could lead to severe curtailment of the use of hydrofluorocarbons (HFCs, the type of refrigerant used in all U.S. automatic commercial ice makers) starting as early as 2012 or as late as 2019. As an example, AHRI pointed to the Waxman legislation, which would set an HFC cap at 370 million metric tons of equivalent carbon dioxide (CO_2e) in 2012, 3 years before this rule takes effect, some 20 percent below estimated industry demand. AHRI stated that, on the other hand, higher energy efficiency commercial ice makers require more refrigerant charge because of larger evaporators and condensers. Therefore, in AHRI's view, it is imperative that DOE carefully study the impact of climate change legislation on the availability and price of HFC refrigerants because there is a real possibility that price will increase significantly and that there will not be enough refrigerants available to meet the new energy conservation standards. (AHRI, No. 16 at p. 5)

AHRI commented that several states have enacted their own climate change legislation to reduce greenhouse gas (GHG) emissions. As an example, AHRI pointed out that the state of California developed regulations to limit GHG emissions to the 1990 levels by year 2020. AHRI further commented that among the measures established by the California Air Resource Board (CARB) are provisions to reduce the use of high global warming potential (GWP) refrigerants such as HFCs in refrigeration and air-conditioning equipment. CARB will implement these regulations in 2011, according to AHRI. (AHRI, No. 16 at p. 6)

Manitowoc commented that the potential phase-out or phase-down of the currently accepted HFC refrigerants is a very significant concern, adding that most commercial ice machines utilize R-404A as the refrigerant, which would be most heavily impacted by any GWP-weighted regulations. Manitowoc stated that development of non-HFC refrigerants has focused on replacement of HFC-134a, to serve automotive applications, and the next priority of refrigerant and component suppliers would be stationary air conditioning, due to the much larger sales volume of these products as compared with ice makers. According to Manitowoc, currently available information indicates that low GWP substitutes for R-404A would lead to reduced energy efficiency in an ice machine application due to the use of zeotropic mixtures with temperature glide and transport property disadvantages. (Manitowoc, No. 19 at p. 4)

The Department performs analyses on the basis of current conditions or in some cases on the basis of conditions that reflect known and predictable changes. If legislation has passed Congress and been signed by the President, the Department would take such regulatory changes into account. However, the Department has consistently declined to speculate on the impact of pending or potential legislation, and has elected to adhere to that long-held policy for this rulemaking.

The California regulations limiting use of high-GWP refrigerants currently apply to stationary refrigeration systems with refrigerant charges of 50 lb or more. Even for these systems, California has not required phase-out of current refrigerants—instead, the regulations include reporting requirements that will help in monitoring and reducing refrigerant leakage.[1] Nearly all automatic commercial ice makers in the harvest capacity range up to 4,000 lb/24 hours have less than 50 lb of refrigerant charge. Hence, this regulation is not expected to significantly affect the ability of manufacturers to use R-404A in future designs.

2.5.8 Outside Regulatory Changes Affecting the Engineering Analysis

Scotsman commented that they are aware of lead limitation requirements in some states that effectively eliminate the possibility of using brass in ice machines. (Scotsman, No. 22 at p. 8)

Scotsman' comment about lead is noted for use in the NOPR phase for the regulatory impact analysis (RIA).

2.6 MARKUPS TO DETERMINE EQUIPMENT PRICE

DOE performs economic analyses of potential energy conservation standard levels, analyzing impacts from the consumer perspective. As a result, DOE needs to develop cost estimates at the consumer level, whereas the results of the cost estimation in the engineering

analysis are at the manufacturer level. In the engineering analyses, DOE estimates MPC, to which DOE adds a manufacturer markup (to recover manufacturer overhead expenses and profits) to estimate an MSP. To estimate the cost to customers buying ice makers, DOE adds markups to reflect the costs added by the wholesale, distribution, and contractor communities that distribute, sell, and install equipment.

2.6.1 Distribution Channels for Automatic Commercial Ice Makers

DOE identified three major distribution channels through which commercial ice-making equipment is purchased by the end user: (1) manufacturer to end user (direct channel); (2) manufacturer to wholesale distributor to end user (wholesaler channel); and (3) manufacturer to distributor to mechanical contractor to end user (contractor channel). DOE presented a preliminary breakdown of the percentage of market shipments going through each distribution channel, based on work done for the commercial refrigeration rulemaking. Interested parties presented various opinions on DOE's assumption regarding distribution channels.

Manitowoc and Scotsman both stated that the distribution channels were correct. Both stated that the majority of shipments require professional installation. Scotsman commented that one distribution chain went from manufacturer to distributor directly to the end user. According to Scotsman, typically machines go from the distributor to a dealer to the end user. (Scotsman, Public Meeting Transcript, No. 13 at p. 167) Scotsman added that a high percentage of sales are replacement sales, and the customer needs something right away; they cannot wait for it to be shipped from the factory. Scotsman commented that it needs to be local, so historically there is a distributor and a dealer in place in a territory. (Scotsman, Public Meeting Transcript, No. 13 at pp. 167–168) Scotsman also added that there is no reason to differentiate between remote condensing and self-contained products because they all go through the same distribution channels. (Scotsman, Public Meeting Transcript, No. 13 at p. 166)

DOE will revise the assumptions regarding percentages of shipments assumed to be through each of the three main distribution chains. U.S. Census of Manufacturers data released since the Framework public meeting validates the manufacturers' comments and will form the basis of the distribution chain weighting for the preliminary analysis. See preliminary TSD chapter 6 for more information.

2.6.2 Methodology for Markups Analysis

Markups are different for different distribution channels, with the direct channel having the smallest markup and the contractor channel having the largest. DOE calculated one average markup value for each level in each distribution channel.

AHRI commented that focusing on retail sale prices instead of attempting to build up from estimates of manufacturer costs and the several markups in the supply chain to the end user will improve the accuracy of the analysis. AHRI stated that when multiple markups (manufacturer, distributor, dealer, and contractor) are estimated, errors are compounded. AHRI added that in their experience, equipment markups are difficult to estimate and often result in retail prices that are lower than what is observed in the market place. AHRI recommended that

DOE, to the extent possible, complement its analysis by surveying the dealer/contractor base to estimate the retail sale price at various efficiencies. (AHRI, No. 16 at pp. 4–5)

Scotsman noted that mechanical contractors are not typically part of ice machine distribution path. (Scotsman, No. 22 at p. 8)

DOE estimates the MPC as part of the engineering analysis, with the manufacturer markup generally determined from industry-wide financial data. The methodology for estimating the production costs is discussed in the engineering analysis (preliminary TSD chapter 5). The methodologies used in determining both the manufacturer markup and the MPC are similar to methods used in numerous past and ongoing DOE rulemakings, with these methodologies having been vetted by numerous interested parties. The retail market is so varied that relying on a market survey to provide consistent, usable, and understandable data would be risky and costly. By building costs from the ground up using the best data available, the Department creates consistent, understandable, and defensible information.

DOE understands from comments that plumbing and mechanical contractors are not typically used, but that customers do frequently rely on third parties—dealers or contractors—for installation and repair work. Because of a lack of a source of dealer markup data, DOE has continued to use mechanical contractors as a proxy for the local distribution level of the distribution chain. Thus, plumbing and mechanical contractors' markups are weighted into markups for transactions involving contractors, as the plumbing/mechanical contractor seems the most directly applicable.

DOE seeks comments on alternative and better sources of data for use in the analyses, as noted in the preliminary TSD chapter 6 and executive summary.

2.6.3 Shipping Costs

DOE estimates MPC and MSP in the engineering analysis by calculating the cost to build the equipment from its components, and then adding a manufacturer markup. Distribution markups are added to determine retail sale prices paid by customers. At present, DOE assumes that shipping costs are embedded in the manufacturing and distribution markups.

DOE notes that the estimated LCC savings and payback period (PBP) analyses are determined by those costs that vary with increasing equipment efficiency. Costs that are constant over all the efficiency levels do not impact analysis results. Shipping costs are generally determined by the size of a unit, and the design options being accounted for in this rulemaking do not result in notable changes in equipment size. Hence, DOE proposed in the Framework document that the shipping costs for higher efficiency equipment would not be different from the shipping costs for the baseline equipment. DOE asked for comment on this assumption.

Scotsman stated that there is no additional shipping cost that should be included with energy efficient equipment, so it would be more or less the same whether it's high efficiency or not. (Scotsman, Public Meeting Transcript, No. 13 at pp. 166–167)

DOE assumed in the preliminary analysis that shipping costs would not increase with the increasing efficiency of the units analyzed.

2.7 ENERGY USE ANALYSIS

2.7.1 Heating, Ventilation, and Cooling Impacts

Automatic commercial ice-making equipment is generally located within a temperature-controlled space. The waste heat generated can therefore impact heating, ventilation, and cooling (HVAC) energy usage. Framework public meeting participants were asked to comment on the Department's plan for evaluating secondary impacts on HVAC.

ACEEE commented that the impacts of water loops might be quite different in a convenience store, a fast food restaurant, a sit-down restaurant, and a hotel. ACEEE suggested that it is not worth getting too deeply into the simulation games, but it might be worth differentiating between uses that lead to beneficial use of the waste energy as compared with those that do not for some specific types of buildings. (ACEEE, Public Meeting Transcript, No. 13 at p. 172)

Scotsman commented that with water-cooled and remote ice makers, the waste heat goes outside and does not affect air conditioning or heating. Scotsman stated that air-cooled machines do provide some heat in the winter, so it is a tradeoff and the modeling has to consider all those factors. (Scotsman, Public Meeting Transcript, No. 13 at p. 174) Scotsman added that larger self-contained air-cooled machines could have a significant impact in a relatively small building. (Scotsman, No. 22 at p. 8)

Manitowoc commented that most of the time the ice-making machine is typically one of the smaller loads compared to all the equipment dumping heat into a commercial kitchen. Manitowoc stated that there is a big internal load, but the ice maker is a small percentage of it. (Manitowoc, Public Meeting Transcript, No. 13 at p. 174) Manitowoc suggested that the one building where ice makers probably have some measurable effect would be a convenience store if they don't use remote condensing, where they can use a lot of ice in a day and there aren't many other significant heat loads. (Manitowoc, Public Meeting Transcript, No. 13 at p. 176)

ASAP commented that it would be very helpful if DOE could present a limited amount of data or modeling, just to provide a sense for the magnitude of impact. (ASAP, Public Meeting Transcript, No. 13 at p. 177) AHRI commented that DOE did this type of analysis for commercial refrigeration rulemaking and found the impact to be negligible, and it was likely not needed. (AHRI, Public Meeting Transcript, No. 13 at p. 178)

The Efficiency Advocates stated that the issue has two sides: the impact of ice-making equipment on building space-conditioning, and the potential for waste heat from ice makers to serve beneficial purposes. As an example, the Efficiency Advocates pointed out that including the heat of compression, an ice maker will reject about twice as much heat as is required to heat the equivalent weight of water, so a water loop connecting the ice maker to a heat pump water heater could improve the efficiency of both. According to the Efficiency Advocates, this is one reason that condenser water use must be treated independently of ice-making water consumption. (Efficiency Advocates, No. 15 at p. 4)

The Department has decided not to analyze the impacts of automatic commercial ice makers' waste heat on HVAC loads. As noted in the comments, remote compressor and water-

cooled units have no impact on HVAC loads. Self-contained air-cooled units do impact HVAC loads. However, the Department has found in prior rulemakings that the impact on total annual energy HVAC usage caused by similar commercial refrigeration equipment was negligible when (1) the analysis focuses on differences caused by the efficiency rulemaking proceedings; and (2) the reductions to air-conditioning energy usage and the increases to space heating usage are combined. The Department agrees with comments that waste heat captured from a closed water loop has potential value. However, heat recovery equipment of this nature is beyond the scope of the current rulemaking because it is an installation issue rather than a manufacturing issue.

2.7.2 Utilization Factors

The utilization factor represents the percent of time that an ice maker actively produces ice. Ice maker usage is measured in terms of kilowatt-hours per 100 lb/24 hours, whereas subsequent analyses require annual energy usage in kilowatt-hours. Thus, a usage factor is required to translate the potential energy usage into estimated annual usage. In the Framework document, the Department presented a series of factors for each type of building that represents an ice maker market segment, and all were set to 0.5, meaning all building types would be modeled with a utilization factor indicating that equipment runs one half of the time.

Manitowoc commented that not all end use segments are at 0.5; some are higher and some are lower. Manitowoc stated that they did not know how one arrives at the numbers, nor did Manitowoc have a good suggestion for how to alter the original assumptions. Manitowoc added that producing numbers would not be easy, and they would need to know how much these assumptions might impact the rulemaking results before undertaking such a task. (Manitowoc, Public Meeting Transcript, No. 13 at pp. 172–173)

Scotsman commented that utilization would be a function of the equipment purchased. Scotsman stated that if one buys a machine that is too big, it will have a low utilization factor; and if one buys one that is too small, it will have a very high utilization factor. Scotsman added that businesses tend to size their machines so they will not run out of ice on the Fourth of July — to have 100 percent utilization on July 4th —and then every other day, they have too much ice and a low utilization rate. According to Scotsman, utilization is also a function of whether the salesperson helped the customer buy a machine that was appropriately sized or one that was too big for the customer's needs. In Scotsman's view, there is much more to it than just utilization factor; it's really about capacity. (Scotsman, Public Meeting Transcript, No. 13 at pp. 173–174)

The energy use baseline and any potential energy savings will be impacted by the assumed values. The Department recognizes that little data exists to derive the utilization factor. DOE would appreciate any data or proposals for methods that will help determine appropriate end use utilization for products in different market segments. As of yet, the Department has not identified a source of data, so for the preliminary analysis the Department will use 0.5 utilization factors.

2.8 LIFE-CYCLE COST AND PAYBACK PERIOD ANALYSES

The effects of amended standards on individual customers usually include a reduction in operating cost and an increase in purchase cost, which together determine the economic impact of standards on individual customers. DOE analyzes two metrics to measure this impact:

- Life-cycle cost is the total customer cost of an appliance or piece of equipment, generally over the life of the appliance or equipment, including purchase and operating costs.
- Payback period measures the amount of time it takes customers to recover the assumed higher purchase price of a more energy efficient piece of equipment through reduced operating costs.

Inputs to the LCC calculation include the installed customer cost of the equipment (customer purchase price plus installation costs and sales tax), and operating expenses (repair, maintenance, energy, and water/wastewater costs), equipment lifetimes, and discount rates.

The LCC and PBP model are developed using Microsoft Excel spreadsheets combined with Crystal Ball, a commercially available add-in for modeling uncertainty.

DOE asked for comments on the methodology and proposed inputs. DOE received a number of comments from interested parties on the LCC and PBP analysis methods and proposed sources of data.

2.8.1 Equipment Lifetimes

Equipment lifetimes are important inputs for determining the LCC savings. The savings in LCC of higher efficiency equipment accrue over the lifetime of the equipment in the form of energy cost savings. In the Framework document, DOE proposed using an equipment lifetime value of 8.5 years for all equipment classes in all building types.

Interested parties provided a variety of comments that agreed in general with DOE's equipment lifetime proposal contained in the Framework document.

AHRI and Manitowoc support DOE's proposed average equipment lifetime of 8.5 years. (AHRI, No. 16 at p. 6; Manitowoc, No. 19 at p. 4)

Hoshizaki estimated product life to be 7–10 years for ice machines. (Hoshizaki, No. 18 at p. 2)

Manitowoc commented that the range of product life discussed at the Framework public meeting was a "pretty good range." Manitowoc added that there is a range because of cycling of all those components, and because they are mechanical parts, it cannot be narrowed down much more than that. (Manitowoc, Public Meeting Transcript, No. 13 at p. 189)

Scotsman commented that the typical life of a commercial ice machine is 7–10 years. (Scotsman, No. 22 at p. 9) Scotsman also commented that a 5-year life is possible if a chain is doing a remodel, and 20 years is possible if the owner does not care how the ice maker looks and therefore does not replace it. (Scotsman, Public Meeting Transcript, No. 13 at p. 190)

Vogt noted that their machines have a useful life in excess of 20 years, while other commercial ice makers typically last 7 years. (Vogt, No. 23 at p. 1)

The Department will use the originally proposed 8.5-year lifetime, and will make the equipment lifetime one of the inputs allowed to vary in the uncertainty analysis. The variation will be derived from distribution functions used in the shipments analysis. Equipment will be modeled as surviving for a period between 4 and 12 years, with weighting factors that yield an average of 8.5 years.

2.8.2 New Markets

When asked about new markets, and in particular about remote condensing units, Manitowoc commented that remote condensing does not appear to be "the next big thing." Manitowoc stated that, on the retail side, remote condensing units go in grocery stores almost exclusively and the only other place would be in very large seafood processing, where they actually need so much ice they would invest in that kind of a unit. According to Manitowoc, grocery stores, if anything, are moving away from the use of flake ice. Manitowoc added that grocery stores still like to use flake ice for certain merchandise like fish where there's an aesthetic appeal, but many produce cases have gone to misting and refrigerated rail systems, and therefore they no longer use flaked ice. (Manitowoc, Public Meeting Transcript, No. 13 at p. 153)

DOE will focus on the markets as proposed in the Framework document and as described in the discussion of shipments (preliminary TSD chapter 9).

2.8.3 Installation, Maintenance, and Repair Costs

Installation costs are the labor and material costs to customers for installing the equipment. Maintenance costs are the labor and material costs for preventative maintenance. The repair costs are the costs to the equipment owner for replacing or repairing equipment components that have failed. During the Framework public meeting and in subsequent written comments, numerous interested parties expressed a variety of views regarding installation, maintenance, and repair costs and the variation of those costs with equipment efficiency.

In the Framework document, given the proposed list of technology options, DOE proposed that there was no reason to believe that higher efficiency equipment would incur any additional installation costs when compared to the baseline equipment. DOE asked interested parties to provide specific information in order for DOE to reconsider such an approach.

With respect to maintenance cost, the Framework document stated that DOE assumed that manufacturers prescribe routine annual or bi-annual preventative maintenance procedures for commercial ice-making equipment. DOE requested input from interested parties on maintenance costs.

Finally, DOE proposed to calculate repair costs as a direct function of the cost of the components to the original ice-making equipment manufacturer. DOE proposed to apply a markup value to the original equipment manufacturer cost to arrive at an approximate cost to

repair or replace a particular component. Again, DOE asked interested parties for input on repair costs.

In response to DOE's preliminary assumption that installation, maintenance, and repair costs should not be modeled as increasing with the level of efficiency, Manitowoc agreed that there should not be any significant effect on the maintenance, repair, or installation cost. (Manitowoc, Public Meeting Transcript, No. 13 at p. 186)

Scotsman commented that maintenance requirements can vary greatly, depending on the environmental conditions, water quality, and location of ice machine. Scotsman stated that routine maintenance typically would be needed at least every 6 months. (Scotsman, Public Meeting Transcript, No. 13 at p. 187) Hoshizaki commented that they recommend cleaning and maintenance of the machine at least once per year depending on the water quality of the area. Hoshizaki also commented that they do not see any savings on maintenance or cleaning for more energy efficient machines. (Hoshizaki, No. 18 at p. 2)

Manitowoc commented that self-contained air, or remote condenser, machines have very different installation costs. (Manitowoc, Public Meeting Transcript, No. 13 at p. 187)

Scotsman did not believe that more energy efficient ice machines will require different maintenance or repair. (Scotsman, No. 22 at p. 9) Scotsman commented that reducing potable water consumption will adversely affect ice machine performance. Scotsman stated that on batch type machines, reducing water consumption will result in cloudy ice (since one is removing less of the impurities) and will result in the need for more frequent cleaning since the impurities will aggregate in the machine and cause problems if not removed. Scotsman added that on water-cooled units, reducing condenser water use can adversely affect energy efficiency. (Scotsman, No. 22 at p. 7)

The Efficiency Advocates commented that, based on the statements of representatives of Scotsman and Manitowoc at the Framework public meeting, they would not expect significant changes in maintenance or repair. (Efficiency Advocates, No. 15 at p. 4)

AHRI commented that it is incorrect to assume that changes in maintenance, repair, and installation will be negligible for more efficient equipment. AHRI recommended that for energy consumption levels that require indoor or outdoor brushless direct current motors or multi-capacity compressors, DOE should survey parts distributors to find the price difference between standard permanent split capacitor and electronically commutated motors, and the difference between two-stage and single-stage compressors. According to AHRI, the dealers usually double their cost on parts when they invoice equipment owners. Furthermore, according to AHRI, the phase out of HCFC-22 and the phase down of HFCs that the U.S. Congress is likely to implement soon will undoubtedly affect the price of refrigerants. AHRI stated that DOE cannot assume that the price to service commercial ice makers will remain constant over time and that it will not change with efficiency. AHRI added that it is very well established that one of the most effective ways to improve efficiency is to increase the size of the evaporator and condenser coils; bigger coils require more refrigerant to initially charge the system and to service it during its lifetime. (AHRI, No. 16 at p. 5)

Based on the comments, DOE retained the initial assumption about efficiency not impacting installation, repair, and maintenance costs, with the caveat that DOE does base repair and maintenance costs, to the extent possible, on any expected changes arising from the technologies studied. Thus, to the extent that any of the technologies listed in the AHRI comment are included in the results, the repair, maintenance, and installation costs will be adjusted to reflect expected added costs. Chapter 5 of the preliminary TSD outlines the engineering design options considered for the various efficiency levels. Chapter 8 of the preliminary TSD discusses the analysis approach for incorporating installation, maintenance, and repair costs and includes further discussion on analyzing design options for potential impact on installation, maintenance, and repair costs.

2.8.4 Electricity and Water/Wastewater Prices

A significant component of the annual operation and maintenance cost of commercial ice makers is energy and water/wastewater costs. In the Framework document, DOE proposed to rely on Energy Information Agency (EIA) information for electricity prices and to evaluate American Water Works Association (AWWA) and other potential sources for water and wastewater prices. DOE asked for comments on these two operation and maintenance costs.

AHRI agreed with DOE's approach to use average electricity process. (AHRI, No. 16 at p. 5)

The Efficiency Advocates stated that potable water use is widely predicted to be a much more important issue than it is today during the expected life of equipment built under the regulations DOE will promulgate in this proceeding. In the view of the Efficiency Advocates, it is imperative to pay attention to potable water use. (Efficiency Advocates, No. 15 at p. 3) The Efficiency Advocates also stated that good proxies are available, and of these, the easiest to use might be the highest decile of water tariffs (including sewage disposal fees) in the United States today. The Efficiency Advocates added that there are enormous variations in the price of water today; for example, according to the Efficiency Advocates, one survey found that the average monthly bill for a family of four using 100 gallons per person per day in major urban areas ranged from $20 to $121.30. The Efficiency Advocates stated that they assume that commercial water rates exhibit similar variations. (Efficiency Advocates, No. 15 at p. 4)

The Department proceeded as proposed in the Framework document. The Department's estimated price of water varies dramatically across states. The variation may provide useful information concerning "winners" and "losers" and how the price of water impacts the outcomes. Preliminary TSD chapter 8 discusses the results of the water price analyses.

2.9 SHIPMENTS ANALYSIS

The shipments analysis is used to estimate future equipment shipments as well as the current stock of automatic commercial ice-making equipment. It provides crucial input for estimating the national energy savings (NES), net present value (NPV), and the MIA.

When asked if standards would impact sales levels for new machines, Scotsman commented that people will not buy new ice machines to get a higher efficiency level. Scotsman stated that machine sales are driven by replacements, so until their current machine breaks,

people do not shop. Scotsman added that the impact of the CEC standards was that manufacturers made any necessary improvements in order to meet the standards, but Scotsman did not know that the California requirements had any effect on sales. (Scotsman, Public Meeting Transcript, No. 13 at p. 194)

Manitowoc commented that most purchasers of commercial ice machines are extremely sensitive to first cost and look for simple payback in a short time period (1 year). Manitowoc stated that higher efficiency standards are likely to increase first cost, and this could have a significant downward impact on shipments if the efficiency levels are based on a longer term LCC analysis. (Manitowoc, No. 19 at p. 4)

Manitowoc commented that one can estimate equipment stock from shipments if one uses the average equipment life time and the data from AHRI. Manitowoc stated that they typically estimate that 70 percent of sales are replacements and the rest is a mix of new construction and some new categories. (Manitowoc, Public Meeting Transcript, No. 13 at p. 193)

Scotsman commented that it is estimated that replacement sales represent 60 to 80 percent of the commercial ice machine market. (Scotsman, No. 22 at p. 2)

Manitowoc supported the use of AHRI in the role of collecting and aggregating data and submitting these data to DOE to provide a representative picture of the entire industry. (Manitowoc, No. 19 at p. 3) AHRI offered to provide historical shipment data, but stated that AHRI does not forecast shipments. (AHRI, Public Meeting Transcript, No. 13 at p. 192) Scotsman pointed out that some tube ice and flake ice machine manufacturers are not part of industry associations, so additional data would probably need to be gathered for some of those categories. (Scotsman, Public Meeting Transcript, No. 13 at p. 111)

DOE used a methodology similar to what Manitowoc suggested to split shipments between replacements and new. DOE appreciates AHRI and the manufacturers providing shipments data.

From the Scotsman comment, DOE understands that the CEC commercial ice maker efficiency standard did not result in a discernible change in equipment sales, while DOE understands from the Manitowoc comment that new standards could reduce shipments. Given the two conflicting comments, for the preliminary analysis, DOE did not model sales as increasing or decreasing as a result of the imposition or strengthening of standards. During manufacturer interviews for the preliminary MIA, responses to questions about the impact on sales of price increases yielded an average impact factor of -0.625 (*i.e.*, a linear response between price and sales indicating a 6.25-percent reduction in sales for a 10-percent cost increase). DOE will consider using the average impact factor during the NOPR stage as a sensitivity case. In the shipments analysis section of the preliminary TSD executive summary, DOE requests additional comments and data on the possible impact of new or increased energy efficiency standards on automatic commercial ice maker shipments.

2.10 NATIONAL IMPACT ANALYSIS

DOE quantifies national impacts of energy conservation standards using two metrics: (1) NES; and (2) NPV of future savings. The NES values, expressed in quads (quadrillion British

thermal units), are the cumulative energy savings as a result of the new standards over the 30-year time frame of DOE's analysis, 2016–2045. The NPV of future savings is also calculated over the 30 years and is expressed in dollars discounted to the present year.

Inputs for NES calculations are: (1) annual unit energy consumption; (2) shipments; (3) equipment stock; and (4) site-to-source conversion factor. Inputs for determining NPV are: (1) total annual installed cost; (2) total annual savings in operating costs; (3) a discount factor; (4) present value of costs; and (5) present value of savings. For the preliminary analysis, DOE proposed to calculate net savings each year as the difference between the base case (scenario in the absence of the proposed standards) and each efficiency level within each equipment class.

One key assumption in the NES calculation is "rebound effect." In the rebound effect, consumers perceive the energy savings as equivalent to an increase in disposable income, and some of the savings are eliminated when customers increase the intensity of their usage of their equipment in response to the perceived income change. DOE stated a belief that there would be no rebound effect with automatic commercial ice makers. DOE asked interested parties for input on the proposed NIA.

ASAP agreed with DOE's assessment of the rebound effect. (ASAP, Public Meeting Transcript, No. 13 at p. 197) Scotsman commented that the cost of ice in a beverage (the main use of ice) is very low compared to the other costs associated with beverage dispensing (ingredients, beverage containers, labor, etc.). In Scotsman's view, because the cost of ice per cup is so low, making it slightly less expensive should have almost no effect on the rate of drink consumption, and thus it can be assumed that there will not be a rebound effect with ice. (Scotsman, No. 22 at p. 10) The Efficiency Advocates stated that rebound effects are unlikely to be large enough to matter for ice makers. (Efficiency Advocates, No. 15 at p. 4)

DOE will proceed with the NES calculations assuming no rebound effect.

2.11 PRELIMINARY MANUFACTURER IMPACT ANALYSIS

DOE conducts the MIA to estimate the financial impact of higher energy conservation standards on manufacturers of commercial ice-making equipment and to calculate the impact of such standards on employment and manufacturing capacity. The MIA has both qualitative and quantitative aspects. The qualitative part of the MIA addresses factors such as equipment characteristics, characteristics of particular firms, and market and equipment trends, and includes an assessment of the impacts of standards on manufacturer subgroups. The preliminary MIA focuses primarily on these qualitative factors. Chapter 12 of the preliminary TSD describes the complete preliminary MIA.

The quantitative part of the MIA is primarily conducted during the rulemaking's NOPR phase and relies on the Government Regulatory Impact Model (GRIM), an industry cash-flow model customized for the commercial ice maker industry. The GRIM inputs include information on the industry cost structure, shipments, and revenues. Much of this information is provided by several of the analyses described above, such as manufacturing costs and prices from the engineering analysis and forecasts from the shipments analysis. The key GRIM output is the

industry NPV, which is calculated for the different trial standard levels examined during the NOPR phase of the rulemaking.

DOE conducts each MIA in three phases and will further tailor the analytical framework for each MIA based on comments from interested parties. In Phase I, the preliminary MIA, DOE creates an industry profile to characterize the industry and identify important issues that require consideration. In Phase II, DOE prepares an industry cash-flow model and interview questionnaire to guide subsequent discussions. In Phase III, DOE interviews manufacturers and assesses the impact of standards. DOE assesses the impact on competition, manufacturing capacity, employment, and regulatory burden using information gained during manufacturer interviews, and assesses impacts to industry and subgroup cash flow and NPV using the GRIM. Phases II and III of the MIA are conducted during the NOPR phase of the rulemaking.

For this rulemaking, DOE gathered preliminary MIA information during the preliminary manufacturer interviews conducted for the engineering analysis. See chapter 12 of the preliminary TSD for a summary of manufacturers' concerns regarding the impacts of new energy conservation standards.

As part of the NOPR, DOE will seek comments from manufacturers about their potential loss of market share, changes in the efficiency distribution for each product class, and the total reduction in equipment shipments at each new energy conservation standard level. DOE will then estimate the impacts on the industry.

The following is an overview of the information DOE will collect and the analysis it will conduct during the remainder of the MIA.

2.11.1 Industry Cash-Flow Analysis

The industry cash-flow analysis relies primarily on the GRIM. DOE uses the GRIM to analyze the financial impacts of more stringent energy conservation standards on the automatic commercial ice maker industry. The GRIM uses many factors to determine annual cash flows from a new standard: annual expected revenues; manufacturer costs, including cost of goods sold, depreciation, research and development, and selling, general, and administrative expenses; taxes; and conversion capital expenditures. DOE compares the results against base-case projections that involve no new standards. The financial impact of new standards is the difference between the two sets of discounted annual cash flows. Other performance metrics such as return on invested capital are also available from the GRIM. For more information on the industry cash-flow analysis, refer to chapter 12 of the preliminary TSD.

2.11.2 Manufacturer Subgroup Analysis

Industry cost estimates are not adequate to assess differential impacts among subgroups of manufacturers. For example, small businesses, manufacturers of niche products, or companies exhibiting a cost structure that differs largely from the industry average could be more negatively affected. Therefore, DOE typically uses the results of the industry characterization to group manufacturers exhibiting similar characteristics.

DOE outlined the process it uses to establish manufacturer subgroups in the Framework document and sought comments from interested parties on any potential subgroups within the industry.

AHRI commented that DOE should examine the impact of the rule on all manufacturers of different product classes. AHRI also commented that DOE should assess impacts on component suppliers, dealers, distributors, and contractors. (AHRI, No. 16 at p. 6)

DOE may assess the potential for capacity constraints, including those from supply chain bottlenecks, in its MIA. However, DOE's MIA for commercial ice-making equipment focuses on the impact of such constraints on manufacturers and not the impact on dealers, distributors, and contractors. EPCA's requirements for consideration of impacts do not extend to these other entities. (42 U.S.C. 6295(o)(2)(B)(i)(I) and 6313(d)(4))

During the manufacturer interview process conducted as part of the NOPR, DOE will discuss the potential subgroups and subgroup members it has identified for the analysis. DOE will encourage manufacturers to recommend subgroups or characteristics appropriate for the subgroup analysis. For more detail on the manufacturer subgroup analysis, see chapter 12 of the preliminary TSD.

2.11.3 Competitive Impacts Assessment

DOE must consider whether a new standard is likely to reduce industry competition, and the Attorney General must determine the impacts, if any, of reduced competition. DOE will attempt to gather and report firm-specific financial information and impacts. The competitive impacts assessment will focus on assessing the impacts on smaller manufacturers. DOE will base this assessment on manufacturing cost data and information collected from interviews with manufacturers. The interviews will focus on gathering information to help assess asymmetrical cost increases to some manufacturers, increased proportion of fixed costs potentially increasing business risks, and potential barriers to market entry (*e.g.*, proprietary technologies). The NOPR will be submitted to the Attorney General for a review of the impacts of standards on competition. The Attorney General's comments on the proposed rule will be considered in preparing the final rule.

2.11.4 Cumulative Regulatory Burden

DOE recognizes and seeks to mitigate the overlapping effects on manufacturers of new or revised DOE standards and other regulatory actions affecting the same equipment. DOE will analyze and consider the impact on manufacturers of multiple, product-specific regulatory actions. DOE outlined the cumulative regulatory burden process in the Framework document and sought comment on any additional regulations facing the commercial ice maker manufacturing industry. DOE received several comments from interested parties regarding cumulative regulatory burden at the Framework public meeting and in written comments.

Some interested parties submitted comments addressing potential regulation limiting use of HFC refrigerants. Some of these comments are discussed in section 2.5.7.

DOE does not intend to analyze the impacts of pending legislation or regulations that have not yet been promulgated. However, DOE incorporates the potential impacts of multiple regulations in the cumulative regulatory burden section of the MIA. DOE will work with manufacturers to understand the regulatory landscape during manufacturer impact interviews.

DOE uses HFC refrigerants as the basis for its analyses. While pending climate change legislation might result in a phase-out or production caps for HFC refrigerants over the course of this rulemaking, any analysis of potential impacts before such legislation is enacted would be speculative. At this time, DOE requests data or information on projected HFC cost increases and the basis for such projections. DOE also seeks comment on the extent to which interested parties expect projected HFC costs to increase, the timing of these increases, and the certainty of the increases.

AHRI commented that several legislative and regulatory activities would significantly burden manufacturers of commercial automatic ice makers. AHRI stated that among the Federal regulatory activities are the DOE energy conservation standards for commercial refrigeration and walk-in refrigerators and freezers. AHRI further stated that, on the legislative side, the Reduction of Lead in Drinking Water Act (S. 3874), signed into law by President Obama on January 4, 2010, and climate change bills that may be considered by Congress in the near future could have a significant negative impact on manufacturers. (AHRI, No. 16 at p. 6)

DOE appreciates these comments and will consider the impact of these Federal and state regulations. In its analysis of the cumulative regulatory burden for ice maker manufacturers, DOE includes the EPACT 2005 standards that went into effect on January 1, 2010.

2.12 LIFE-CYCLE COST SUBGROUP ANALYSIS

The LCC subgroup analysis evaluates economic impacts on selected customer subgroups that might be adversely affected by a change in the national energy conservation standards for the considered equipment. DOE evaluates impacts on particular subgroups of customers in part by analyzing the LCC impacts and PBP for those particular customers.

DOE will use the LCC spreadsheet model to evaluate impacts on customer subgroups. DOE can analyze the LCC for any subgroup by applying the LCC spreadsheet model to only that subgroup. DOE is particularly sensitive to increases in the customer price and LCC of the considered equipment, wishing to avoid a negative economic impact on any identified customer subgroup.

DOE will review the available information with respect to the identified customer subgroups. DOE will consider investigating the impacts on independent grocery stores, small convenience stores, and independent foodservice establishments as consumer subgroups in its LCC subgroup analysis.

2.13 UTILITY IMPACT ANALYSIS

The utility impact analysis includes an analysis of the effect of new energy conservation standards on the electric and the gas utility industries. For this analysis, DOE adapted the National Energy Modeling System (NEMS), a large multi-sectoral, partial-equilibrium model of

the U.S. energy sector that the EIA developed throughout the past decade primarily for preparing EIA's *Annual Energy Outlook* (*AEO*). In previous rulemakings, a variant of NEMS (currently termed NEMS-BT, BT referring to DOE's Building Technologies program) was developed to address the specific impacts of an energy conservation standard.

Available in the public domain, NEMS produces a widely recognized baseline energy forecast for the United States through 2035. The typical NEMS outputs include forecasts of electricity sales, prices, and electric generating capacity. The energy savings impacts from amended energy conservation standards are modeled using NEMS-BT to generate forecasts that deviate from the *AEO* reference case.

Inclusion of the dampening effect of standards on electricity prices is an issue that affects all equipment standards rulemakings. In the absence of an appropriate methodology for measuring such effects, DOE will not take the dampening effect into consideration for this rulemaking, but will continue to consider the development of an appropriate methodology.

2.14 EMISSIONS ANALYSIS

In the emissions analysis, DOE estimates the reduction in power sector emissions of carbon dioxide (CO_2), nitrogen oxides (NO_x), and mercury (Hg) using the NEMS-BT computer model. In the emissions analysis, NEMS-BT is run similarly to the *AEO* NEMS, except that automatic commercial ice-making equipment energy use is reduced by the amount of energy saved (by fuel type) due to each trial standard level. The inputs of NES come from the NIA spreadsheet model, while the output is the forecasted physical emissions. The net benefit of each considered standard level is the difference between the forecasted emissions estimated by NEMS-BT at that level and the *AEO2011* Reference Case.

2.14.1 Carbon Dioxide

In the absence of any Federal emissions control regulation of power plant emissions of CO_2, a DOE standard is likely to result in reductions of these emissions. The CO_2 emission reductions likely to result from a standard will be estimated using NEMS-BT and NES estimates drawn from the NIA spreadsheet model. The net benefit of the standard is the difference between emissions estimated by NEMS-BT at each standard level considered and the *AEO* Reference Case. NEMS-BT tracks CO_2 emissions using a detailed module that provides results with broad coverage of all sectors and inclusion of interactive effects.

2.14.2 Sulfur Dioxide

SO_2 emissions from affected electricity generating units (EGUs) are subject to nationwide and regional emissions cap and trading programs, and DOE has preliminarily determined that these programs create uncertainty about the potential standards' impact on SO_2 emissions. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous states and the District of Columbia (D.C.). SO_2 emissions from 28 eastern states and D.C. are also limited under the Clean Air Interstate Rule (CAIR, 70 FR 25162 (May 12, 2005)), which created an allowance-based trading program. Although CAIR was remanded to the U.S. Environmental Protection Agency (EPA) by the U.S. Court of Appeals for the District of Columbia Circuit (D.C. Circuit). See *North Carolina v. EPA*, 550 F.3d 1176 (D.C.

Cir. 2008), it remains in effect temporarily, consistent with the D.C. Circuit's earlier opinion in *North Carolina v. EPA*, 531 F.3d 896 (D.C. Cir. 2008). On July 6, 2010, EPA issued the Transport Rule proposal, a replacement for CAIR. 75 FR 45210 (Aug. 2, 2010). EPA issued the final transport rule, titled the Cross-State Air Pollution Rule, on July 6, 2011. 76 FR 48208 (Aug. 8, 2011). Because the *AEO2011* NEMS that DOE is using for this emissions analysis assumes the implementation of CAIR, DOE has not been able to take into account the effects of the Transport Rule for this emissions analysis. [i]

The attainment of emissions caps is typically flexible among EGUs and is enforced through the use of emissions allowances and tradable permits. Under existing EPA regulations, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the imposition of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by any regulated EGU. However, if the standard resulted in a permanent increase in the quantity of unused emissions allowances, there would be an overall reduction in SO_2 emissions from the standards. While there remains some uncertainty about the ultimate effects of efficiency standards on SO_2 emissions covered by the existing cap and trade system, the NEMS-BT modeling system that DOE uses to forecast emissions reductions currently indicates that no physical reductions in power sector emissions would occur for SO_2.

2.14.3 Nitrogen Oxides

The CAIR established a cap on NO_x emissions in 28 eastern states and the District of Columbia. All these states and D.C. have elected to reduce their NO_x emissions by participating in cap and trade programs for EGUs. Therefore, energy conservation standards for automatic commercial ice makers may have little or no physical effect on these emissions in the 28 eastern states and the D.C. for the same reasons that they may have little or no physical effect on NO_x emissions. DOE uses the NEMS-BT to estimate NO_x emissions reductions from possible standards in the states where emissions are not capped.

2.14.4 Mercury

Similar to emissions of SO_2 and NO_x, future emissions of Hg would have been subject to emissions caps. In May 2005, EPA issued the Clean Air Mercury Rule (CAMR). 70 FR 28606 (May 18, 2005). CAMR would have permanently capped emissions of mercury for new and existing coal-fired power plants in all states by 2010. However, on February 8, 2008, the D.C. Circuit issued a decision in *New Jersey v. Environmental Protection Agency*, in which it vacated CAMR. 517 F.3d 574 (D.C. Cir. 2008). EPA has decided to develop emissions standards for power plants under the Clean Air Act (section 112), consistent with the D.C. Circuit's opinion on CAMR. See www.epa.gov/air/mercuryrule/pdfs/certpetition_withdrawal.pdf. Pending EPA's forthcoming revisions to the rule, DOE would exclude CAMR from any emission analysis that it may prepare for this rulemaking. In the absence of CAMR, a DOE standard would likely reduce Hg emissions, and DOE plans to use NEMS-BT to estimate these emission reductions. However,

[i] DOE notes that future iterations of the NEMS-BT model will incorporate any changes necessitated by issuance of the Cross-State Air Pollution Rule.

DOE continues to review the impact of rules that reduce energy consumption on Hg emissions, and may revise its assessment of Hg emission reductions in future rulemakings.

2.14.5 Particulate Matter

DOE acknowledges that PM exposure can impact human health. Power plant emissions can have either direct or indirect impacts on PM. A portion of the pollutants emitted by a power plant, called direct or primary PM emissions, are in the form of particulates as they leave the smoke stack. However, the great majority of PM emissions associated with power plants are in the form of secondary sulfates, which are produced a significant distance away from power plants by complex atmospheric chemical reactions that often involve the gaseous (non-particulate) emissions of power plants, mainly SO_2 and NO_x. The quantity of the secondary sulfates produced is determined by a very complex set of factors including the atmospheric quantities of SO_2 and NO_x, and other atmospheric constituents and conditions. Because these highly complex chemical reactions produce PM comprised of different constituents from different sources, EPA does not distinguish direct PM emissions from power plants from the secondary sulfate particulates in its ambient air quality requirements, PM monitoring of ambient air quality, or PM emissions inventories. For these reasons, it is not currently possible to determine how the amended standard impacts either direct or indirect PM emissions. Therefore, DOE is not planning to assess the impact of these standards on PM emissions. Further, as described previously, it is uncertain whether efficiency standards will result in a net decrease in power plant emissions of SO_2, which are now largely regulated by cap and trade systems.

DOE seeks input on its plans to use NEMS-BT to conduct the environmental assessment for the products covered by this rulemaking.

2.15 MONETIZING CARBON AND OTHER EMISSIONS REDUCTIONS BENEFITS

DOE plans to consider the estimated monetary benefits likely to result from the reduced emissions of CO_2 and NO_x that are expected to result from each of the standard levels considered.

In order to estimate the monetary value of benefits resulting from reduced emissions of CO_2, DOE plans to use the most current Social Cost of Carbon (SCC) values developed and/or agreed to by an interagency process. The SCC is intended to be a monetary measure of the incremental damage resulting from GHG emissions, including, but not limited to, net agricultural productivity loss, human health effects, property damage from sea level rise, and changes in ecosystem services. Any effort to quantify and to monetize the harms associated with climate change will raise serious questions of science, economics, and ethics. But with full regard for the limits of both quantification and monetization, the SCC can be used to provide estimates of the social benefits of reductions in GHG emissions.

At the time of this notice, the most recent interagency estimates of the potential global benefits resulting from reduced CO_2 emissions in 2010, expressed in 2010$, were $4.9, $22.3, $36.5, and $67.6 per metric ton avoided. For emission reductions that occur in later years, these values grow in real terms over time. Additionally, the interagency group determined that a range of values from 7 percent to 23 percent should be used to adjust the global SCC to calculate

domestic effects, although DOE will give preference to consideration of the global benefits of reducing CO_2 emissions. To calculate a present value of the stream of monetary values, DOE will discount the values in each of the four cases using the discount rates that had been used to obtain the SCC values in each case.

DOE recognizes that scientific and economic knowledge continues to evolve rapidly as to the contribution of CO_2 and other GHG to changes in the future global climate and the potential resulting damages to the world economy. Thus, these values are subject to change.

DOE also intends to estimate the potential monetary benefit of reduced NO_x emissions resulting from the standard levels it considers. For NO_x emissions, available estimates suggest a very wide range of monetary values for NO_x emissions, ranging from $450 to $4,623 per ton in 2010$).[j] In accordance with Office of Management and Budget (OMB) guidance, DOE will conduct two calculations of the monetary benefits derived using each of the economic values used for NO_x, one using a real discount rate of 3 percent and another using a real discount rate of 7 percent.[k]

DOE does not plan to monetize estimates of Hg in this rulemaking. DOE is aware of multiple agency efforts to determine the appropriate range of values used in evaluating the potential economic benefits of reduced Hg emissions. DOE has decided to await further guidance regarding consistent valuation and reporting of Hg emissions before it once again monetizes Hg in its rulemakings.

DOE received a few comments on the monetization of pollutants. AHRI commented the Department has no statutory responsibility to establish a monetary value for potential environmental benefits of appliance standards options, and that Department should not allow evaluation of environmental impacts to negate or make moot what has always been, and should remain, the core analysis in appliance standards rulemakings, *i.e.*, consumer payback and LCC analysis. AHRI added that there is currently no consensus on any single estimate of the value of CO_2 emissions, and therefore DOE should not indulge in speculation to determine a value when it has no statutory obligation to do so. (AHRI, No. 16 at pp. 6–7)

AHRI also commented that DOE must also estimate additional CO_2 emissions resulting from the production of the more efficient units. AHRI stated that this would include the mining and production of increased volume of raw materials, original equipment manufacturer factory retooling, additional trucks needed to ship larger units, and additional warehouse space needed for larger units among others. (AHRI, No. 16 at p. 7)

As described in this section, DOE uses a procedure provided by an interagency working group for the monetization of CO_2 emissions and continues to modify this procedure as guidance changes. Evaluation of emission impacts is an independent analysis and does not influence the

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[j] For additional information, refer to U.S. Office of Management and Budget, Office of Information and Regulatory Affairs, 2006 Report to Congress on the Costs and Benefits of Federal Regulations and Unfunded Mandates on State, Local, and Tribal Entities, Washington, D.C.

[k] OMB, Circular A-4: Regulatory Analysis (Sept. 17, 2003).

LCC and PBP analyses. DOE's emissions analysis is standard for all DOE rulemakings and may change in the future as the interagency guidance evolves.

2.16 EMPLOYMENT IMPACT ANALYSIS

The imposition of standards can affect employment both directly and indirectly. Direct employment impacts are changes in the number of employees at plants that produce covered equipment and at the affiliated distribution and service companies. DOE evaluates direct employment impacts in the MIA. Indirect employment impacts may result from customers shifting expenditures between goods (the substitution effect) and from changes in income and overall expenditure levels (the income effect). DOE will use Pacific Northwest National Laboratory's (PNNL's) Impact of Sector Energy Technologies (ImSET) model to investigate the combined direct and indirect employment impacts. The ImSET model, which was developed for DOE's Office of Planning, Budget, and Analysis, estimates the employment and income effects energy saving technologies produce in buildings, industry, and transportation. Compared with simple economic multiplier approaches, ImSET allows for more complete analysis of the economic impacts of energy conservation investments.

2.17 REGULATORY IMPACT ANALYSIS

In the NOPR, DOE will prepare an RIA pursuant to Executive Order 12866, *Regulatory Planning and Review*, 58 FR 51735 (Oct. 4, 1993). The RIA is subject to review under the Executive Order by the Office of Information and Regulatory Affairs at the OMB. The RIA addresses the potential for non-regulatory approaches to supplant or augment energy conservation standards in order to improve the energy efficiency or reduce the energy consumption of the equipment covered under this rulemaking.

DOE recognizes that non-regulatory efforts by manufacturers, utilities, and other interested parties can substantially improve energy efficiency or reduce energy consumption. For the NOPR, DOE will base its assessment on the actual impacts of any such initiatives to date, but will also consider information presented by interested parties on the impacts that existing initiatives might have in the future.

REFERENCES

1. G. Gallagher. *Personal communication*. California Air Resources Board. CA Assembly Bill No. 32. September 13, 2011.