

## DEPARTMENT OF ENERGY

### 10 CFR Part 431

[EERE–2017–BT–STD–0007]

RIN 1904–AD82

#### Energy Conservation Program: Energy Conservation Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers

**AGENCY:** Office of Energy Efficiency and Renewable Energy, Department of Energy.

**ACTION:** Final rule.

**SUMMARY:** The Energy Policy and Conservation Act, as amended (“EPCA”), prescribes energy conservation standards for various consumer products and certain commercial and industrial equipment, including commercial refrigerators, freezers, and refrigerator-freezers (“commercial refrigeration equipment” or “CRE”). EPCA also requires the U.S. Department of Energy (“DOE”) to periodically review its existing standards to determine whether more-stringent standards would be technologically feasible and economically justified and would result in significant energy savings. In this final rule, DOE is adopting new and amended energy conservation standards for CRE. It has determined that the new and amended energy conservation standards for this equipment would result in significant conservation of energy and are technologically feasible and economically justified.

**DATES:** The effective date of this rule is March 24, 2025. Compliance with the new and amended standards established for commercial refrigerators, freezers, and refrigerator-freezers in this final rule is required on and after Monday, January 22, 2029. The incorporation by reference of certain material listed in this rule was approved by the Director of the Federal Register as of March 10, 2009 and October 23, 2013.

**ADDRESSES:** The docket for this rulemaking, which includes **Federal Register** notices, public meeting attendee lists and transcripts, comments, and other supporting documents/materials, is available for review at [www.regulations.gov](http://www.regulations.gov). All documents in the docket are listed in the [www.regulations.gov](http://www.regulations.gov) index. However, not all documents listed in the index may be publicly available, such as information that is exempt from public disclosure.

The docket web page can be found at [www.regulations.gov/docket/EERE-2017-BT-STD-0007](http://www.regulations.gov/docket/EERE-2017-BT-STD-0007). The docket web

page contains instructions on how to access all documents, including public comments, in the docket.

For further information on how to review the docket, contact the Appliance and Equipment Standards Program staff at (202) 287–1445 or by email: [ApplianceStandardsQuestions@ee.doe.gov](mailto:ApplianceStandardsQuestions@ee.doe.gov).

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### I. Synopsis of the Final Rule

EPCA, Public Law 94–163, as amended,<sup>1</sup> authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317, as codified) Title III, Part C of EPCA,<sup>2</sup> added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311–6317, as codified) Such equipment includes CRE, the subject of this rulemaking. (42 U.S.C. 6311(1)(E))

Pursuant to EPCA, DOE is required to review its existing energy conservation standards for covered equipment no later than 6 years after issuance of any final rule establishing or amending a standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(1)) Pursuant to that statutory provision, DOE must publish

<sup>1</sup> All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Public Law 116–260 (Dec. 27, 2020), which reflects the last statutory amendments that impact Parts A and A–1 of EPCA.

<sup>2</sup> For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

either a notification of determination that standards for the product do not need to be amended, or a notice of proposed rulemaking (“NOPR”) including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (*Id.*) Any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(A)) Furthermore, the new or amended standard must result in significant conservation of energy. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(B)) DOE has conducted this review of the energy conservation standards for CRE under EPCA’s 6-year-lookback authority described herein. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(1))

In accordance with these and other statutory provisions discussed in this document, DOE analyzed the benefits and burdens of six trial standard levels (“TSLs”) for CRE. The TSLs and their associated benefits and burdens are discussed in detail in sections V.A through V.C of this document. As discussed in section V.C of this document, DOE has determined that TSL 3 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. The adopted standards, which are expressed in maximum daily energy consumption (“MDEC”) as a function of the volume or total display area (“TDA”), are shown in table I.1. These standards apply to all equipment listed in table I.1 and manufactured in, or imported into, the United States starting on the date 4 years after the publication of the final rule for this rulemaking. As discussed in section II.B.3 of this document, DOE is not, at this time, amending standards for the large-capacity CRE ranges presented in table IV.6 for the VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L equipment classes.

**BILLING CODE 6450–01–P**



**Table I.1 Energy Conservation Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers (Compliance Starting January 22, 2029)**

Equipment Class	Capacity Range	Maximum Daily Energy Consumption <i>kWh/day</i> *
VOP.RC.H	All TDAs are applicable	$0.551 \times \text{TDA} + 3.506$
VOP.RC.M	All TDAs are applicable	$0.591 \times \text{TDA} + 3.758$
VOP.RC.L	All TDAs are applicable	$2.079 \times \text{TDA} + 6.472$
VOP.RC.I	All TDAs are applicable	$2.637 \times \text{TDA} + 8.222$
SVO.RC.H	All TDAs are applicable	$0.572 \times \text{TDA} + 2.756$
SVO.RC.M	All TDAs are applicable	$0.611 \times \text{TDA} + 2.944$
SVO.RC.L	All TDAs are applicable	$2.079 \times \text{TDA} + 6.473$
SVO.RC.I	All TDAs are applicable	$2.637 \times \text{TDA} + 8.222$
HZO.RC.H	All TDAs are applicable	$0.350 \times \text{TDA} + 2.880$
HZO.RC.M	All TDAs are applicable	$0.350 \times \text{TDA} + 2.880$
HZO.RC.L	All TDAs are applicable	$0.550 \times \text{TDA} + 6.880$
HZO.RC.I	All TDAs are applicable	$0.700 \times \text{TDA} + 8.740$
VCT.RC.H	All TDAs are applicable	$0.150 \times \text{TDA} + 1.950$
VCT.RC.M	All TDAs are applicable	$0.150 \times \text{TDA} + 1.950$
VCT.RC.L	All TDAs are applicable	$0.490 \times \text{TDA} + 2.610$
VCT.RC.I	All TDAs are applicable	$0.580 \times \text{TDA} + 3.050$
HCT.RC.M	All TDAs are applicable	$0.160 \times \text{TDA} + 0.130$
HCT.RC.L	All TDAs are applicable	$0.340 \times \text{TDA} + 0.260$
HCT.RC.I	All TDAs are applicable	$0.356 \times \text{TDA} + 0.276$
VCS.RC.H	All volumes are applicable	$0.100 \times V + 0.260$
VCS.RC.M	All volumes are applicable	$0.100 \times V + 0.260$
VCS.RC.L	All volumes are applicable	$0.210 \times V + 0.540$
VCS.RC.I	All volumes are applicable	$0.250 \times V + 0.630$
HCS.RC.M	All volumes are applicable	$0.100 \times V + 0.260$
HCS.RC.L	All volumes are applicable	$0.210 \times V + 0.540$
HCS.RC.I	All volumes are applicable	$0.250 \times V + 0.630$
SOC.RC.H	All TDAs are applicable	$0.440 \times \text{TDA} + 0.110$
SOC.RC.M	All TDAs are applicable	$0.440 \times \text{TDA} + 0.110$
SOC.RC.L	All TDAs are applicable	$0.930 \times \text{TDA} + 0.220$
SOC.RC.I	All TDAs are applicable	$0.970 \times \text{TDA} + 0.231$
CB.RC.M	All volumes are applicable	$0.050 \times V + 0.686$
CB.RC.L	All volumes are applicable	$0.194 \times V + 1.693$
VOP.SC.H	All TDAs are applicable	$0.890 \times \text{TDA} + 2.480^{****}$
VOP.SC.M – Non-Large	$\text{TDA} \leq 17$	$1.230 \times \text{TDA} + 3.428$
VOP.SC.M – Large***	$\text{TDA} > 17$	$1.69 \times \text{TDA} + 4.71$
VOP.SC.L	All TDAs are applicable	$3.092 \times \text{TDA} + 8.598$
VOP.SC.I	All TDAs are applicable	$3.928 \times \text{TDA} + 10.926$

SVO.SC.H	All volumes are applicable	$1.045 \times \text{TDA} + 2.822$
SVO.SC.M – Non-Large	$\text{TDA} \leq 15$	$1.207 \times \text{TDA} + 3.258$
SVO.SC.M – Large***	$\text{TDA} > 15$	$1.7 \times \text{TDA} + 4.59$
SVO.SC.L	All TDAs are applicable	$3.024 \times \text{TDA} + 8.169$
SVO.SC.I	All TDAs are applicable	$3.840 \times \text{TDA} + 10.384$
HZO.SC.H	All TDAs are applicable	$0.546 \times \text{TDA} + 4.211$
HZO.SC.M	All TDAs are applicable	$0.532 \times \text{TDA} + 4.100$
HZO.SC.L – Non-Large	$\text{TDA} \leq 35$	$1.490 \times \text{TDA} + 5.554$
HZO.SC.L – Large***	$\text{TDA} > 35$	$1.9 \times \text{TDA} + 7.08$
HZO.SC.I	All TDAs are applicable	$1.900 \times \text{TDA} + 7.065$
VCT.SC.H	All volumes are applicable	$0.047 \times V + 0.493$
VCT.SC.M – Non-Large	$V \leq 100$	$0.073 \times V + 0.630$
VCT.SC.M with Feature**	$V \leq 100$	$0.078 \times V + 0.674$
VCT.SC.M – Large***	$V > 100$	$0.1 \times V + 0.86$
VCT.SC.L – Non-Large	$V \leq 70$	$0.233 \times V + 2.374$
VCT.SC.L with Feature**	$V \leq 70$	$0.249 \times V + 2.540$
VCT.SC.L – Large***	$V > 70$	$0.29 \times V + 2.95$
VCT.SC.I	All TDAs are applicable	$0.620 \times \text{TDA} + 3.290$
HCT.SC.M	All volumes are applicable	$0.060 \times V + 0.370$
HCT.SC.L	All volumes are applicable	$0.080 \times V + 1.230$
HCT.SC.I	All TDAs are applicable	$0.498 \times \text{TDA} + 0.383$
VCS.SC.H	All volumes are applicable	$0.021 \times V + 0.793$
VCS.SC.M	All volumes are applicable	$0.038 \times V + 1.039$
VCS.SC.M with Feature**	All volumes are applicable	$0.041 \times V + 1.112$
VCS.SC.L – Non-Large	$V \leq 100$	$0.169 \times V + 1.059****$
VCS.SC.L with Feature**	$V \leq 100$	$0.181 \times V + 1.133$
VCS.SC.L – Large***	$V > 100$	$0.22 \times V + 1.38$
VCS.SC.I	All volumes are applicable	$0.264 \times V + 0.683$
HCS.SC.M	All volumes are applicable	$0.037 \times V + 0.675$
HCS.SC.L	All volumes are applicable	$0.055 \times V + 1.033$
HCS.SC.L with Feature**	All TDAs are applicable	$0.059 \times V + 1.105$
HCS.SC.I	All volumes are applicable	$0.313 \times V + 0.811$
SOC.SC.H	All TDAs are applicable	$0.304 \times \text{TDA} + 0.584$
SOC.SC.M – Non-Large	$\text{TDA} \leq 40$	$0.356 \times \text{TDA} + 0.685$
SOC.SC.M – Large***	$\text{TDA} > 40$	$0.52 \times \text{TDA} + 1.$
SOC.SC.L	All TDAs are applicable	$1.100 \times \text{TDA} + 2.100$
SOC.SC.I	All TDAs are applicable	$1.530 \times \text{TDA} + 0.360$
CB.SC.M	All volumes are applicable	$0.081 \times V + 1.117$



CB.SC.L	All volumes are applicable	$0.297 \times V + 2.591$
PD.SC.M	All volumes are applicable	$0.11 \times V + 0.81$

The equipment classes are separated by equipment family, condensing unit configuration, and operating temperature.

Equipment Families: VOP – Vertical Open; SVO – Semi-Vertical Open; HZO – Horizontal Open; VCT – Vertical Closed Transparent; HCT – Horizontal Closed Transparent; VCS – Vertical Closed Solid; HCS – Horizontal Closed Solid; SOC – Service Over Counter; CB – Chef Base or Griddle Stand; PD – Pull Down. Condensing Unit Configurations: RC – Remote Condensing; SC – Self-Contained.

Operating Temperatures: H – High Temperature; M – Medium Temperature; L – Low Temperature; I – Ice Cream Temperature.

\* V is the volume, expressed in ft<sup>3</sup>, as determined in appendix B to subpart C of part 431. TDA is the total display area, expressed in ft<sup>2</sup>, as determined in appendix B to subpart C of part 431.

\*\* For equipment classes designated “with Feature,” refer to table I.2 for the list of qualifying features applicable to each class.

\*\*\* As discussed in section II.B.3 of this document, DOE is continuing to analyze the large-capacity ranges presented in table IV.6 for the VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L equipment classes.

\*\*\*\* The equations for VOP.SC.H and VCS.SC.L were written incorrectly in the August 2024 NODA Support Document and have been corrected here which is consistent with the secondary mapping in table 4.1 of the August 2024 NODA.

**Table I.2 Applicable Features for Equipment Classes Designated “with Feature” for Maximum Daily Energy Consumption Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers**

Equipment Class	Applicable Feature(s)
VCT.SC.M ( $\leq 100$ )	Pass-through doors Sliding doors Both pass-through and sliding doors Roll-in doors Roll-through doors
VCT.SC.L ( $\leq 70$ )	Pass-through doors
VCS.SC.M	Pass-through doors Roll-in doors Roll-through doors Drawer units
VCS.SC.L ( $\leq 100$ )	Pass-through doors Roll-in doors Roll-through doors Drawer units
HCS.SC.L	Forced air evaporator

## BILLING CODE 6450-01-C

ARI Standard 1200-2006 and AHRI Standard 1200 (I-P)-2010 are referenced in the amendatory text of this document and were previously approved for § 431.66.

A. Benefits and Costs to Consumers<sup>3</sup>

Table I.3 summarizes DOE's evaluation of the economic impacts of the adopted standards on consumers of CRE, as measured by the average life-cycle cost ("LCC") savings and the

simple payback period ("PBP").<sup>4</sup> The average LCC savings are positive for all equipment classes, and the PBP is less than the average lifetime of CRE, which is estimated to be 14.0 years (see section IV.F of this document).

## BILLING CODE 6450-01-P

**Table I.3 Impacts of Adopted Energy Conservation Standards on Consumers of CRE**

CRE Class	Average LCC Savings 2023\$	Simple Payback Period years
CB.SC.L	163.6	4.0
CB.SC.M	8.1	6.8
HCS.SC.L	24.1	3.2
HCS.SC.M	18.9	4.0
HCT.SC.I	29.3	7.0
HCT.SC.L	0.0	0.0
HCT.SC.M	0.0	0.0
HZO.RC.L	0.0	0.0
HZO.RC.M	0.0	0.0
HZO.SC.L	1243.6	2.4
HZO.SC.M	312.9	2.6
SOC.RC.M	0.0	0.0
SOC.SC.M	443.5	2.4
SVO.RC.M	97.1	2.4
SVO.SC.M	578.9	4.1
VCS.SC.H	9.8	4.0
VCS.SC.I	488.2	3.1
VCS.SC.L	470.5	2.2
VCS.SC.M	29.1	3.0
VCT.RC.L	0.0	0.0
VCT.RC.M	0.0	0.0
VCT.SC.H	19.3	4.0
VCT.SC.I	0.0	0.0
VCT.SC.L	436.9	3.5
VCT.SC.M	33.2	6.5
VOP.RC.L	1300.4	0.9
VOP.RC.M	337.4	1.8
VOP.SC.M	1867.5	1.4

## BILLING CODE 6450-01-C

DOE's analysis of the impacts of the adopted standards on consumers is described in section IV.F of this document.

## B. Impact on Manufacturers

The industry net present value ("INPV") is the sum of the discounted cash flows to the industry from the base year through the end of the analysis period (2024-2058). Using a real discount rate of 10.0 percent, DOE estimates that the INPV for manufacturers of CRE in the case

without new and amended standards is \$3,022.3 million in 2023\$. Under the adopted standards, DOE estimates the change in INPV to range from -2.6 percent to -1.7 percent, which is approximately -\$77.8 million to -\$51.3 million. In order to bring equipment into compliance with new and amended standards, it is estimated that industry will incur total conversion costs of \$117.7 million.

DOE's analysis of the impacts of the adopted standards on manufacturers is described in section IV.J of this document. The analytic results of the

manufacturer impact analysis ("MIA") are presented in section V.B.2 of this document.

## C. National Benefits and Costs

DOE's analyses indicate that the adopted energy conservation standards for CRE would save a significant amount of energy. The adopted TSL is TSL 3. Relative to the case without new and amended standards, the lifetime energy savings for CRE purchased during the 30-year period that begins in the anticipated year of compliance with the new and amended standards (2029-

<sup>3</sup> All monetary values in this document are expressed in 2023 dollars unless indicated otherwise. For purposes of discounting future monetary values, the present year in the analysis was 2024.

<sup>4</sup> The average LCC savings refer to consumers that are affected by a standard and are measured relative to the efficiency distribution in the no-new-standards case, which depicts the market in the compliance year in the absence of new or amended

standards (see section IV.F.9 of this document). The simple PBP, which is designed to compare specific efficiency levels, is measured relative to the baseline product (see section IV.C of this document).

2058) amount to 1.11 quadrillion British thermal units (“Btu”), or quads.<sup>5</sup> This represents a savings of 6.5 percent relative to the energy use of this equipment in the case without new and amended standards (referred to as the “no-new-standards case”).

The cumulative net present value (“NPV”) of total consumer benefits of the standards for CRE ranges from \$1.32 billion 2023\$ (at a 7-percent discount rate) to \$3.43 billion 2023\$ (at a 3-percent discount rate). This NPV expresses the estimated total value of future operating-cost savings minus the estimated increased equipment costs for CRE purchased during the period 2029–2058.

In addition, the adopted standards for CRE are projected to yield significant environmental benefits. DOE estimates that the standards will result in cumulative emission reductions (over the same period as for energy savings) of 19.7 million metric tons (“Mt”)<sup>6</sup> of carbon dioxide (“CO<sub>2</sub>”), 6.0 thousand tons of sulfur dioxide (“SO<sub>2</sub>”), 36.9 thousand tons of nitrogen oxides (“NO<sub>x</sub>”), 168 thousand tons of methane (“CH<sub>4</sub>”), 0.2 thousand tons of nitrous oxide (“N<sub>2</sub>O”), and 0.04 tons of mercury (“Hg”).<sup>7</sup>

<sup>5</sup> The quantity refers to full-fuel-cycle (“FFC”) energy savings. FFC energy savings includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and, thus, presents a more complete picture of the impacts of energy efficiency standards. For more information on the FFC metric, see section IV.H.2 of this document.

<sup>6</sup> A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO<sub>2</sub> are presented in short tons.

<sup>7</sup> DOE calculated emissions reductions relative to the no-new-standards case, which reflects key assumptions in the *Annual Energy Outlook 2023* (“*AEO2023*”). *AEO2023* represents current federal and state legislation and final implementation of regulations as of the time of its preparation. See

DOE estimates the value of climate benefits from a reduction in greenhouse gases (“GHG”) using different estimates of the social cost of CO<sub>2</sub> (“SC–CO<sub>2</sub>”), the social cost of methane (“SC–CH<sub>4</sub>”), and the social cost of nitrous oxide (“SC–N<sub>2</sub>O”). Together these represent the social cost of GHG (“SC–GHG”). DOE used an updated set of SC–GHG estimates (in terms of benefit per ton of GHG avoided) published in 2023 by the Environmental Protection Agency (“EPA”) (“2023 SC–GHG”), as well as the interim SC–GHG values developed by an Interagency Working Group on the Social Cost of Greenhouse Gases (“IWG”) in 2021 (“2021 Interim SC–GHG”), which DOE used in the notice of proposed rulemaking for this rule before the updated values were available.<sup>8</sup> These values are discussed in section IV.L of this document. The climate benefits associated with the average SC–GHG at a 2-percent near-term Ramsey discount rate using the 2023 SC–GHG estimates are estimated to be \$4.6 billion, and the climate benefits associated with the average 2021 Interim SC–GHG estimates at a 3-percent discount rate are estimated to be \$1.12 billion. DOE notes, however, that the adopted standards would be economically justified even without

chapter 13 of this final rule TSD for further discussion of AEO2023 assumptions that affect air pollutant emissions.

<sup>8</sup> Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990 published in February 2021 by the IWG. (“February 2021 SC–GHG TSD”). [www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument\\_SocialCostofCarbonMethaneNitrousOxide.pdf](http://www.whitehouse.gov/wp-content/uploads/2021/02/TechnicalSupportDocument_SocialCostofCarbonMethaneNitrousOxide.pdf) [https://www.epa.gov/system/files/documents/2023-12/eo12866\\_oil-and-gas-nsp-eg-climate-review-2060-av16-final-rule-20231130.pdf](https://www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsp-eg-climate-review-2060-av16-final-rule-20231130.pdf); [https://www.epa.gov/system/files/documents/2023-12/epa-scghg\\_2023\\_report\\_final.pdf](https://www.epa.gov/system/files/documents/2023-12/epa-scghg_2023_report_final.pdf) (last accessed July 3, 2024).

inclusion of the estimated monetized benefits of reduced GHG emissions.

DOE estimated the monetary health benefits of SO<sub>2</sub> and NO<sub>x</sub> emissions reductions using benefit-per-ton estimates from the EPA’s Benefits Mapping and Analysis Program<sup>9</sup> as discussed in Section IV.L of this document. DOE did not monetize the change in mercury emissions because the quantity is very small. DOE estimated the present value of the health benefits would be \$0.86 billion using a 7-percent discount rate, and \$2.19 billion using a 3-percent discount rate.<sup>10</sup> DOE is currently only monetizing health benefits from changes in ambient fine particulate matter (“PM<sub>2.5</sub>”) concentrations from two precursors (SO<sub>2</sub> and NO<sub>x</sub>), and from changes in ambient ozone from one precursor (NO<sub>x</sub>), but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct PM<sub>2.5</sub> emissions.

Table I.4 summarizes the monetized benefits and costs expected to result from the new and amended standards for CRE. There are other important unquantified effects, including certain unquantified climate benefits, unquantified public health benefits from the reduction of toxic air pollutants and other emissions, unquantified energy security benefits, and distributional effects, among others.

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<sup>9</sup> Estimating the Benefit per Ton of Reducing Directly-Emitted PM<sub>2.5</sub>, PM<sub>2.5</sub> Precursors and Ozone Precursors from 21 Sectors. Available at [www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors](http://www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors).

<sup>10</sup> DOE estimates the economic value of these emissions reductions resulting from the considered TSLs for the purpose of complying with the requirements of Executive Order 12866.



**Table I.4 Summary of Monetized Benefits and Costs of the Adopted Energy Conservation Standards for CRE at TSL 3 Shipped During the Period 2029–2058**

	Billion 2023\$
<b>3% discount rate</b>	
Consumer Operating Cost Savings	4.61
Climate Benefits* (2023 SC-GHG estimates)	4.60
Climate Benefits* (2021 interim SC-GHG estimates)	1.12
Health Benefits**	2.19
Total Benefits† (2023 SC-GHG estimates)	11.4
Total Benefits† (2021 interim SC-GHG estimates)	7.92
Consumer Incremental Equipment Costs‡	1.18
Net Benefits† (2023 SC-GHG estimates)	10.2
Net Benefits† (2021 interim SC-GHG estimates)	6.74
Change in Producer Cash Flow (INPV)**	(0.08) – (0.05)
<b>7% discount rate</b>	
Consumer Operating Cost Savings	1.99
Climate Benefits* (2023 SC-GHG estimates)	4.60
Climate Benefits* (2021 interim SC-GHG estimates)	1.12
Health Benefits**	0.86
Total Benefits† (2023 SC-GHG estimates)	7.45
Total Benefits† (2021 interim SC-GHG estimates)	3.96
Consumer Incremental Equipment Costs	0.67
Net Benefits† (2023 SC-GHG estimates)	6.78
Net Benefits† (2021 interim SC-GHG estimates)	3.29
Change in Producer Cash Flow (INPV)**	(0.08) – (0.05)

Note: These results include consumer, climate, and health benefits that accrue after 2058 from the equipment shipped during the period 2029–2058.

\* Climate benefits are calculated using different estimates of the social cost of carbon (SC-CO<sub>2</sub>), methane (SC-CH<sub>4</sub>), and nitrous oxide (SC-N<sub>2</sub>O). Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) (“2023 SC-GHG”) and the interim set of estimates used in the NOPR which were published in 2021 by the Interagency Working Group on the SC-GHG (IWG) (“2021 Interim SC-GHG”) (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 2 percent near-term Ramsey discount rate are shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown for the 2021 interim SC-GHG estimates.

\*\* Health benefits are calculated using benefit-per-ton values for NO<sub>x</sub> and SO<sub>2</sub>. DOE is currently only monetizing (for SO<sub>2</sub> and NO<sub>x</sub>) PM<sub>2.5</sub> precursor health benefits and (for NO<sub>x</sub>) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct PM<sub>2.5</sub> emissions. Table 5 of the EPA’s *Estimating the Benefit per Ton of Reducing PM<sub>2.5</sub> Precursors from 21 Sectors* TSD provides a summary of the health impact endpoints quantified in the analysis. See section IV.L of this document for more details.

† Total and net benefits include those consumer, climate, and health benefits that can be quantified and monetized. For presentation purposes, total and net benefits for both the 3-percent and 7-percent cases are presented using the



average SC-GHG with a 2 percent near term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 interim SC-GHG estimates

Operating Cost Savings are calculated based on the life-cycle cost analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's national impact analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the equipment and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, manufacturer impact analysis, or "MIA"). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cash flow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. Change in INPV is calculated using the industry weighted-average cost of capital value of 10.0 percent that is estimated in the MIA (see chapter 12 of the final rule technical support document ("TSD") for a complete description of the industry weighted-average cost of capital). For CRE, the change in INPV ranges from -\$79 million to -\$51 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two manufacturer markup scenarios: the preservation-of-gross-margin scenario, which is the manufacturer markup scenario used in the calculation of consumer operating cost savings in this table; and the preservation-of-operating-profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated INPV in the above table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the net benefit calculation using the 2023 SC-GHG estimates for this final rule, the net benefits would range from \$10.12 billion to \$10.15 billion at 3-percent discount rate and would range from \$6.70 billion to \$6.73 billion at 7-percent discount rate.

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The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The monetary values for the total annualized net benefits are: (1) the reduced consumer operating costs, minus (2) the increase in equipment purchase prices and installation costs, plus (3) the value of climate and health benefits of emission reductions, all annualized.<sup>11</sup>

The national operating cost savings are domestic private U.S. consumer monetary savings that occur as a result of purchasing the covered equipment and are measured for the lifetime of CRE shipped during the period 2029–2058. The benefits associated with reduced emissions achieved as a result of the adopted standards are also calculated based on the lifetime of CRE shipped during the period 2029–2058. Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with a 2 percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-

GHG with 3-percent discount rate for the 2021 interim SC-GHG estimates.<sup>12</sup>

Table I.5 presents the total estimated monetized benefits and costs associated with the adopted standard, expressed in terms of annualized values. The results under the primary estimates are as follows.

Using a 7-percent discount rate for consumer benefits and costs and health benefits from reduced NO<sub>x</sub> and SO<sub>2</sub> emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards adopted in this rule is \$71 million per year in increased equipment costs, while the estimated annual benefits are \$210 million in reduced equipment operating costs, \$222 million per year in climate benefits (using the 2023 SC-GHG estimates) or \$64 million per year in climate benefits (using the 2021 interim SC-GHG estimates), and \$90 million in health benefits. In this case, the net benefit would amount to

\$452 million per year (using the 2023 SC-GHG estimates) or \$294 million per year (using the 2021 interim SC-GHG estimates).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NO<sub>x</sub> and SO<sub>2</sub> emissions, and either the 2-percent near-term Ramsey discount rate case or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated cost of the standards is \$68 million per year in increased equipment costs, while the estimated annual benefits are \$265 million in reduced operating costs, \$222 million in climate benefits (using the 2023 SC-GHG estimates) or \$64 million in climate benefits (using the 2021 interim SC-GHG estimates), and \$126 million in health benefits. In this case, the net benefit would amount to \$545 million per year (using the 2023 SC-GHG estimates) or \$387 million per year (using the 2021 interim SC-GHG estimates).

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<sup>11</sup> To convert the time-series of costs and benefits into annualized values, DOE calculated a present value in 2024, the year used for discounting the NPV of total consumer costs and savings. For the benefits, DOE calculated a present value associated with each year's shipments in the year in which the shipments occur (*e.g.*, 2020 or 2030), and then

discounted the present value from each year to 2024. Using the present value, DOE then calculated the fixed annual payment over a 30-year period, starting in the compliance year, that yields the same present value.

<sup>12</sup> DOE notes that using consumption-based discount rates (*e.g.*, 2 or 3 percent) is appropriate

when discounting the value of climate impacts. Combining climate effects discounted at an appropriate consumption-based discount rate with other costs and benefits discounted at a capital-based rate (*i.e.*, 7 percent) is reasonable because of the different nature of the types of benefits being measured.



**Table I.5 Annualized Benefits and Costs of the Adopted Energy Conservation Standards for CRE at TSL 3 Shipped During the Period 2029–2058**

	Million 2023\$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
<b>3% discount rate</b>			
Consumer Operating Cost Savings	265	254	278
Climate Benefits* (2023 SC-GHG)	222	221	228
Climate Benefits* (2021 interim SC-GHG estimates)	64.2	63.8	65.8
Health Benefits**	126	125	129
Total Benefits† (2023 SC-GHG estimates)	613	600	634
Total Benefits† (2021 interim SC-GHG estimates)	455	443	472
Consumer Incremental Equipment Costs‡	68	108	69
Net Benefits (2023 SC-GHG estimates)	545	492	565
Net Benefits (2021 interim SC-GHG estimates)	387	335	403
Change in Producer Cash Flow (INPV)**	(8) – (5)	(8) – (5)	(8) – (5)
<b>7% discount rate</b>			
Consumer Operating Cost Savings	210	202	220
Climate Benefits* (2023 SC-GHG)	222	221	228
Climate Benefits* (2021 interim SC-GHG estimates)	64.2	63.8	65.8
Health Benefits**	90	90	92
Total Benefits† (2023 SC-GHG estimates)	523	513	540
Total Benefits† (2021 interim SC-GHG estimates)	365	356	378
Consumer Incremental Equipment Costs	71	107	72
Net Benefits (2023 SC-GHG estimates)	452	406	468
Net Benefits (2021 interim SC-GHG estimates)	294	250	306
Change in Producer Cash Flow (INPV)**	(8) – (5)	(8) – (5)	(8) – (5)

Note: These results include consumer, climate, and health benefits that accrue after 2058 from the equipment shipped during the period 2029–2058. The Primary, Low-Net-Benefits, and High-Net-Benefits Estimates utilize projections of energy prices from the *AEO2023* Reference case, Low Economic Growth case, and High Economic Growth case, respectively. In addition, incremental equipment costs reflect a price decline rate (applicable to LED lighting and electronics in variable speed compressors) in the Primary and High-Net-Benefits Estimates, and no price-decline for the Low-Net-Benefits Estimate. The methods used to derive projected price trends are explained in sections IV.F of this document. Note that the Benefits and Costs may not sum to the Net Benefits due to rounding.

\* Climate benefits are calculated using different estimates of the global SC-GHG (see section IV.L of this document). Climate benefits are estimated using two separate sets of estimates of the social cost for each greenhouse gas, an updated set published in 2023 by the Environmental Protection Agency (EPA) (“2023 SC-GHG”) and the interim set of estimates used in the NOPR which were published in 2021 by the Interagency Working Group on the SC-GHG (IWG) (“2021 Interim SC-GHG”) (see section IV.L of this document). For presentational purposes of this table, the climate benefits associated with the average SC-GHG at a 2 percent near-term Ramsey discount rate are



shown for the 2023 SC-GHG estimates, and the climate benefits associated with the average SC-GHG at a 3 percent discount rate are shown for the 2021 interim SC-GHG estimates.

\*\* Health benefits are calculated using benefit-per-ton values for NO<sub>x</sub> and SO<sub>2</sub>. DOE is currently only monetizing (for SO<sub>2</sub> and NO<sub>x</sub>) PM<sub>2.5</sub> precursor health benefits and (for NO<sub>x</sub>) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct PM<sub>2.5</sub> emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM<sub>2.5</sub> Precursors from 21 Sectors TSD* provides a summary of the health impact endpoints quantified in the analysis. See section IV.L of this document for more details.

† Total benefits for both the 3-percent and 7-percent cases are presented using the average SC-GHG with 2-percent near-term Ramsey discount rate for the 2023 SC-GHG estimates and the average SC-GHG with 3-percent discount rate for the 2021 interim SC-GHG estimates.

‡‡ Operating Cost Savings are calculated based on the life-cycle cost analysis and national impact analysis as discussed in detail below. See sections IV.F and IV.H of this document. DOE's national impacts analysis includes all impacts (both costs and benefits) along the distribution chain beginning with the increased costs to the manufacturer to manufacture the product and ending with the increase in price experienced by the consumer. DOE also separately conducts a detailed analysis on the impacts on manufacturers (*i.e.*, MIA). See section IV.J of this document. In the detailed MIA, DOE models manufacturers' pricing decisions based on assumptions regarding investments, conversion costs, cash flow, and margins. The MIA produces a range of impacts, which is the rule's expected impact on the INPV. The change in INPV is the present value of all changes in industry cash flow, including changes in production costs, capital expenditures, and manufacturer profit margins. The annualized change in INPV is calculated using the industry weighted-average cost of capital value of 10.0 percent that is estimated in the MIA (see chapter 12 of the final rule TSD for a complete description of the industry weighted-average cost of capital). For CRE, the annualized change in INPV ranges from -\$8.2 million to -\$5.3 million. DOE accounts for that range of likely impacts in analyzing whether a TSL is economically justified. See section V.C of this document. DOE is presenting the range of impacts to the INPV under two markup manufacturer scenarios: the preservation-of-gross margin scenario, which is the manufacturer markup scenario used in the calculation of consumer operating cost savings in this table; and the preservation-of-operating-profit scenario, where DOE assumed manufacturers would not be able to increase per-unit operating profit in proportion to increases in manufacturer production costs. DOE includes the range of estimated annualized change in INPV in the above table, drawing on the MIA explained further in section IV.J of this document to provide additional context for assessing the estimated impacts of this final rule to society, including potential changes in production and consumption, which is consistent with OMB's Circular A-4 and E.O. 12866. If DOE were to include the INPV into the annualized net benefit calculation using the 2023 SC-GHG estimates for this final rule, the annualized net benefits would range from \$537 million to \$540 million at 3-percent discount rate and would range from \$444 million to \$447 million at 7-percent discount rate.

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DOE's analysis of the national impacts of the adopted standards is described in sections IV.H, IV.K, and IV.L of this document.

#### D. Conclusion

DOE concludes that the standards adopted in this final rule represent the maximum improvement in energy efficiency that is technologically feasible and economically justified and would result in the significant conservation of energy. Specifically, with regards to technological feasibility, design options used to achieve these standard levels are already commercially available for all equipment classes covered by this final rule. As for economic justification, DOE's analysis shows that the benefits of the standards exceed, to a great extent, the burdens of the standards.

Using a 7-percent discount rate for consumer benefits and costs and NO<sub>x</sub> and SO<sub>2</sub> reduction benefits, and a 2-percent near-term Ramsey discount rate

case or the 3-percent discount rate case for GHG social costs, the estimated cost of the standards for CRE is \$71 million per year in increased equipment costs, while the estimated annual benefits are \$210 million in reduced equipment operating costs, \$222 million in climate benefits (using the 2023 SC-GHG estimates) or \$64 million in climate benefits (using the 2021 interim SC-GHG estimates), and \$90 million in health benefits. The net benefit amounts to \$452 million per year (using the 2023 SC-GHG estimates) or \$294 million per year (using the 2021 interim SC-GHG estimates). DOE notes that the net benefits are substantial even in the absence of the climate benefits,<sup>13</sup> and DOE would adopt the same standards in the absence of such benefits.

The significance of energy savings offered by a new or amended energy conservation standard cannot be

determined without knowledge of the specific circumstances surrounding a given rulemaking.<sup>14</sup> For example, some covered equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these equipment on the energy infrastructure can be more pronounced than the impacts of equipment with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis.

As previously mentioned, the standards are projected to result in estimated national energy savings ("NES") of 1.11 quad full-fuel-cycle ("FFC"), the equivalent of the primary annual energy use of 7.4 million homes. Based on these findings, DOE has determined the energy savings from the

<sup>13</sup> The information on climate benefits is provided in compliance with Executive Order 12866.

<sup>14</sup> Procedures, Interpretations, and Policies for Consideration in New or Revised Energy Conservation Standards and Test Procedures for Consumer Products and Commercial/Industrial Equipment, 86 FR 70892, 70901 (Dec. 13, 2021).

standard levels adopted in this final rule are “significant” within the meaning of 42 U.S.C. 6295(o)(3)(B). A more detailed discussion of the basis for these conclusions is contained in the remainder of this document and the accompanying technical support document (“TSD”).

## II. Introduction

The following section briefly discusses the statutory authority underlying this final rule, as well as some of the relevant historical background related to the establishment of standards for CRE.

### A. Authority

EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. (42 U.S.C. 6291–6317, as codified) Title III, Part C of EPCA,<sup>15</sup> added by Public Law 95–619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. (42 U.S.C. 6311–6317) EPCA specifies a list of equipment that constitutes covered equipment (hereafter referred to as “covered equipment”).<sup>16</sup> This equipment includes commercial refrigerators, freezers, and refrigerator-freezers, the subject of this document. (42 U.S.C. 6311(1)(E))

The energy conservation program under EPCA consists essentially of four parts: (1) testing, (2) labeling, (3) the establishment of Federal energy conservation standards, and (4) certification and enforcement procedures. Relevant provisions of EPCA include definitions (42 U.S.C. 6311), test procedures (42 U.S.C. 6314), labeling provisions (42 U.S.C. 6315), energy conservation standards (42 U.S.C. 6313), and the authority to require information and reports from manufacturers (42 U.S.C. 6316(e)(1); 42 U.S.C. 6296(a), (b), and (d)).

Federal energy efficiency requirements for covered equipment

established under EPCA generally supersede State laws and regulations concerning energy conservation testing, labeling, and standards. (42 U.S.C. 6316(e)(2)–(3); 42 U.S.C. 6297(a)–(c)) DOE may, however, grant waivers of Federal preemption in limited circumstances for particular State laws or regulations, in accordance with the procedures and other provisions set forth under EPCA. (42 U.S.C. 6316(e)(2)–(3); 42 U.S.C. 6297(d))

Subject to certain criteria and conditions, DOE is required to develop test procedures to measure the energy efficiency, energy use, or estimated annual operating cost of covered equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(A) and 42 U.S.C. 6295(r)) Manufacturers of covered equipment must use the Federal test procedures as the basis for certifying to DOE that their equipment complies with the applicable energy conservation standards and as the basis for any representations regarding the energy use or energy efficiency of the equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(s); 42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to evaluate whether a basic model complies with the applicable energy conservation standard(s). (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(s)). The DOE test procedures for CRE appear at 10 CFR 431, subpart C, appendix B (“appendix B”).

EPCA prescribed energy conservation standards for CRE (42 U.S.C. 6313(c)) and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6313(c)(6)) Not later than six years after the issuance of any final rule establishing or amending a standard, DOE must publish either a notice of determination (“NOPD”) that standards for the equipment do not need to be amended, or a NOPR including new proposed energy conservation standards (proceeding to a final rule, as appropriate). (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(1)) DOE must make the analysis on which a NOPD or NOPR is based publicly available and provide an opportunity for written comment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(2)) Not later than two years after a NOPR is issued, DOE must publish a final rule amending the energy conservation standard for the equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(3)(A))

DOE must follow specific statutory criteria for prescribing new or amended standards for covered equipment, including CRE. Any new or amended standard for covered equipment must be designed to achieve the maximum improvement in energy efficiency that

the Secretary of Energy (“Secretary”) determines is technologically feasible and economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(A)) Furthermore, DOE may not adopt any standard that would not result in the significant conservation of energy. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(B))

Moreover, DOE may not prescribe a standard if: (1) for certain equipment, including CRE, no test procedure has been established for the product; or (2) DOE determines by rule that the establishment of such standard will not result in significant conservation of energy (or, for certain products, water), or is not technologically feasible or economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(A)–(B)) In deciding whether a proposed standard is economically justified, DOE must determine whether the benefits of the standard exceed its burdens. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)) DOE must make this determination after receiving comments on the proposed standard, and by considering, to the greatest extent practicable, the following seven statutory factors:

(1) The economic impact of the standard on manufacturers and consumers of the equipment subject to the standard;

(2) The savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price, initial charges, or maintenance expenses for the covered equipment that are likely to result from the standard;

(3) The total projected amount of energy (or as applicable, water) savings likely to result directly from the standard;

(4) Any lessening of the utility or the performance of the covered equipment likely to result from the standard;

(5) The impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from the standard;

(6) The need for national energy and water conservation; and

(7) Other factors the Secretary considers relevant.

(42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII))

Further, EPCA, as codified, establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing equipment complying with an energy conservation standard level will be less than three times the value of the energy savings during the first year that the consumer will receive as a result of the standard, as calculated under the applicable test procedure. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(iii))

<sup>15</sup> As noted previously, for editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A–1.

<sup>16</sup> “Covered equipment” means one of the following types of industrial equipment: Electric motors and pumps; small commercial package air-conditioning and heating equipment; large commercial package air-conditioning and heating equipment; very large commercial package air-conditioning and heating equipment; commercial refrigerators, freezers, and refrigerator-freezers; automatic commercial ice makers; walk-in coolers and walk-in freezers; commercial clothes washers; packaged terminal air conditioners and packaged terminal heat pumps; warm air furnaces and packaged boilers; and storage water heaters, instantaneous water heaters, and unfired hot water storage tanks. (42 U.S.C. 6311(1)(A)–(K))



EPCA, as codified, also contains what is known as an “anti-backsliding” provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of covered equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(1)) Also, the Secretary may not prescribe an amended or new standard if interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered equipment type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available in the United States. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(4))

Additionally, EPCA specifies requirements when promulgating an energy conservation standard for covered equipment that has two or more subcategories. A rule prescribing an energy conservation standard for a type (or class) of equipment must specify a different standard level for a type or class of equipment that has the same

function or intended use if DOE determines that equipment within such group (A) consumes a different kind of energy from that consumed by other covered equipment within such type (or class); or (B) has a capacity or other performance-related feature which other products within such type (or class) do not have and such feature justifies a higher or lower standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(q)(1)) In determining whether a performance-related feature justifies a different standard for a group of equipment, DOE considers such factors as the utility to the consumer of such a feature and other factors DOE deems appropriate. (*Id.*) Any rule prescribing such a standard must include an explanation of the basis on which such higher or lower level was established. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(q)(2))

DOE is publishing this final rule pursuant to the six-year-lookback review requirement in EPCA described herein.

#### *B. Background*

##### **1. Current Standards**

DOE most recently completed a review of its CRE standards in a final

rule published in the **Federal Register** on March 28, 2014 (“March 2014 Final Rule”), through which DOE prescribed the current energy conservation standards for CRE manufactured on and after March 27, 2017. 79 FR 17725. These standards are set forth in DOE’s regulations at 10 CFR 431.66(e) and are shown in table II.1.

For CRE with two or more compartments (*i.e.*, hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers), 10 CFR 431.66(e)(2) specifies that the maximum daily energy consumption for each model shall be the sum of the applicable standard for each of the compartments, as specified in 10 CFR 431.66(e)(1). For wedge cases, 10 CFR 431.66(e)(3) specifies instructions to comply with the applicable standards specified in 10 CFR 431.66(e)(1). Certain exclusions to the standards at 10 CFR 431.66(e)(1) are specified at 10 CFR 431.66(f).

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**Table II.1 Federal Energy Efficiency Standards for CRE**

Condensing Unit Configuration	Equipment Family	Rating Temperature (°F)	Operating Temperature (°F)	Equipment Class Designation*	Maximum Daily Energy Consumption (kWh/day)
Remote Condensing (RC)	Vertical Open (VOP)	38.0 (M)	≥ 32.0	VOP.RC.M	0.64 x TDA + 4.07
		0.0 (L)	< 32.0	VOP.RC.L	2.2 x TDA + 6.85
		-15.0 (I)	≤ -5.0	VOP.RC.I	2.79 x TDA + 8.7
	Semivertical Open (SVO)	38.0 (M)	≥ 32.0	SVO.RC.M	0.66 x TDA + 3.18
		0.0 (L)	< 32.0	SVO.RC.L	2.2 x TDA + 6.85
		-15.0 (I)	≤ -5.0	SVO.RC.I	2.79 x TDA + 8.7
	Horizontal Open (HZO)	38.0 (M)	≥ 32.0	HZO.RC.M	0.35 x TDA + 2.88
		0.0 (L)	< 32.0	HZO.RC.L	0.55 x TDA + 6.88
		-15.0 (I)	≤ -5.0	HZO.RC.I	0.7 x TDA + 8.74
	Vertical Closed Transparent (VCT)	38.0 (M)	≥ 32.0	VCT.RC.M	0.15 x TDA + 1.95
		0.0 (L)	< 32.0	VCT.RC.L	0.49 x TDA + 2.61
		-15.0 (I)	≤ -5.0	VCT.RC.I	0.58 x TDA + 3.05
	Horizontal Closed Transparent (HCT)	38.0 (M)	≥ 32.0	HCT.RC.M	0.16 x TDA + 0.13
		0.0 (L)	< 32.0	HCT.RC.L	0.34 x TDA + 0.26
		-15.0 (I)	≤ -5.0	HCT.RC.I	0.4 x TDA + 0.31
	Vertical Closed Solid (VCS)	38.0 (M)	≥ 32.0	VCS.RC.M	0.1 x V + 0.26
		0.0 (L)	< 32.0	VCS.RC.L	0.21 x V + 0.54
		-15.0 (I)	≤ -5.0	VCS.RC.I	0.25 x V + 0.63
	Horizontal Closed Solid (HCS)	38.0 (M)	≥ 32.0	HCS.RC.M	0.1 x V + 0.26
		0.0 (L)	< 32.0	HCS.RC.L	0.21 x V + 0.54
		-15.0 (I)	≤ -5.0	HCS.RC.I	0.25 x V + 0.63
	Service Over Counter (SOC)	38.0 (M)	≥ 32.0	SOC.RC.M	0.44 x TDA + 0.11
		0.0 (L)	< 32.0	SOC.RC.L	0.93 x TDA + 0.22
		-15.0 (I)	≤ -5.0	SOC.RC.I	1.09 x TDA + 0.26
Self-Contained (SC)	Vertical Open (VOP)	38.0 (M)	≥ 32.0	VOP.SC.M	1.69 x TDA + 4.71
		0.0 (L)	< 32.0	VOP.SC.L	4.25 x TDA + 11.82
		-15.0 (I)	≤ -5.0	VOP.SC.I	5.4 x TDA + 15.02
	Semivertical Open (SVO)	38.0 (M)	≥ 32.0	SVO.SC.M	1.7 x TDA + 4.59
		0.0 (L)	< 32.0	SVO.SC.L	4.26 x TDA + 11.51
		-15.0 (I)	≤ -5.0	SVO.SC.I	5.41 x TDA + 14.63
	Horizontal Open (HZO)	38.0 (M)	≥ 32.0	HZO.SC.M	0.72 x TDA + 5.55
		0.0 (L)	< 32.0	HZO.SC.L	1.9 x TDA + 7.08
		-15.0 (I)	≤ -5.0	HZO.SC.I	2.42 x TDA + 9
	Vertical Closed Transparent (VCT)	38.0 (M)	≥ 32.0	VCT.SC.M	0.1 x V + 0.86
		0.0 (L)	< 32.0	VCT.SC.L	0.29 x V + 2.95
		-15.0 (I)	≤ -5.0	VCT.SC.I	0.62 x TDA + 3.29
	Vertical Closed Solid (VCS)	38.0 (M)	≥ 32.0	VCS.SC.M	0.05 x V + 1.36
		0.0 (L)	< 32.0	VCS.SC.L	0.22 x V + 1.38
		-15.0 (I)	≤ -5.0	VCS.SC.I	0.34 x V + 0.88
	Horizontal Closed Transparent (HCT)	38.0 (M)	≥ 32.0	HCT.SC.M	0.06 x V + 0.37
		0.0 (L)	< 32.0	HCT.SC.L	0.08 x V + 1.23
		-15.0 (I)	≤ -5.0	HCT.SC.I	0.56 x TDA + 0.43
	Horizontal Closed Solid (HCS)	38.0 (M)	≥ 32.0	HCS.SC.M	0.05 x V + 0.91
		0.0 (L)	< 32.0	HCS.SC.L	0.06 x V + 1.12
		-15.0 (I)	≤ -5.0	HCS.SC.I	0.34 x V + 0.88
	Service Over Counter (SOC)	38.0 (M)	≥ 32.0	SOC.SC.M	0.52 x TDA + 1
		0.0 (L)	< 32.0	SOC.SC.L	1.1 x TDA + 2.1
		-15.0 (I)	≤ -5.0	SOC.SC.I	1.53 x TDA + 0.36
	Pull-Down (PD)	38.0 (M)	≥ 32.0	PD.SC.M	0.11 x V + 0.81



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## 2. History of Standards Rulemaking for Commercial Refrigerators, Freezers, and Refrigerator-Freezers

On July 16, 2021, DOE published a request for information (“RFI”) in the **Federal Register** to undertake an early assessment review for amended energy conservation standards for CRE to determine whether to amend applicable energy conservation standards for this equipment (“July 2021 RFI”). 86 FR 37708. Specifically, through the published notice and RFI, DOE sought data and information that could enable the agency to determine whether amended energy conservation standards would: (1) result in a significant savings of energy, (2) be technologically feasible, and (3) be economically justified. *Id.*

On June 28, 2022, DOE published in the **Federal Register** a notification of the

availability of a preliminary TSD for CRE (“June 2022 Preliminary Analysis”). 87 FR 38296. In that notification, DOE sought comment on the analytical framework, models, and tools that DOE used to evaluate potential standards for CRE, the results of preliminary analyses performed, and the potential energy conservation standard levels derived from these analyses, which DOE presented in the accompanying preliminary TSD (“June 2022 Preliminary TSD”).<sup>17</sup> *Id.* DOE held a public meeting related to the June 2022 Preliminary Analysis on August 8, 2022.

On October 10, 2023, DOE published in the **Federal Register** a NOPR to establish and amend energy

<sup>17</sup> The June 2022 Preliminary TSD is available in the docket for this rulemaking at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0013](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0013).

conservation standards for CRE (“October 2023 NOPR”). 88 FR 70196. DOE also sought comment on the analytical framework, models, and tools that DOE used to evaluate the proposed standards for CRE, the results of the NOPR analyses performed, and the proposed new and amended energy conservation standard levels derived from these analyses, which DOE presented in the accompanying NOPR TSD (“October 2023 NOPR TSD”).<sup>18</sup> *Id.* DOE held a public meeting related to the October 2023 NOPR on November 7, 2023 (hereafter, the “November 2023 Public Meeting”).

DOE received comments in response to the October 2023 NOPR from the interested parties listed in table II.2.

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<sup>18</sup> The October 2023 NOPR TSD is available in the docket for this rulemaking at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0051](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0051).

**Table II.2 List of Commenters with Written Submissions in Response to the October 2023 NOPR**

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
True Manufacturing*	True	72	Manufacturer
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Natural Resources Defense Council	ASAP <i>et al.</i>	79	Efficiency Organizations
National Automatic Merchandising Association	NAMA	85	Trade Association
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	81	Trade Association
ITW Food Equipment Group, - Traulsen **	ITW	82	Manufacturer
North American Association of Food Equipment Manufacturers	NAFEM	83	Trade Association
Pacific Gas and Electric Company, San Diego Gas and Electric, and Southern California Edison; collectively, the California Investor Owned Utilities	CA IOUs	84	Utility
Continental Refrigerator**	Continental	86	Manufacturer
Delfield Company	Delfield	71	Manufacturer
Due North	Due North	87	Manufacturer
Food Marketing Institute, National Association of Convenience Stores	FMI and NACS	78	Trade Associations
Hillphoenix**	Hillphoenix	77	Manufacturer
Hoshizaki America	Hoshizaki	76	Manufacturer
Husmann Corporation	Husmann	80	Manufacturer
Michael Ravnitzky	Ravnitzky	57	Individual
Kirby Foods, INC.	Kirby	66	Grocery Store Business
Northwest Energy Efficiency Alliance, Northwest Power and Conservation Council	NEEA and NPCC	89	Efficiency Organizations
New York State Energy Research and Development Authority	NYSERDA	88	Efficiency Organization
Structural Concepts Corporation	SCC	74	Manufacturer
StoreMasters, LLC	Storemasters	68	Supermarket Architecture Design Firm
ITW-Food Equipment Group	ITW	82	Manufacturer
Zero Zone, Inc.	Zero Zone	75	Manufacturer
Zach Killin	Killin	59	Individual
Anonymous*	Individual Commenter	70	Individual
Anonymous*	Individual Commenter	58	Individual
Anonymous*	Individual Commenter	73	Individual

\* These commenters submitted confidential comments

\*\* These commenters submitted confidential comments in addition to public comments



November 2023 Public Meeting, DOE cites the written comments throughout this document. Any oral comments provided during the November 2023 Public Meeting that are not substantively addressed by written comments are summarized and cited separately throughout this document.

On August 28, 2024, DOE published in the **Federal Register** a notice of data availability (“NODA”) to provide updated analytical results that reflect updates to the analysis that DOE is considering based on feedback received in response to the October 2023 NOPR (“August 2024 NODA”). 89 FR 68788.

DOE also sought comment, data, and information regarding the updated analyses. *Id.*

DOE received comments in response to the August 2024 NODA from the interested parties listed in table II.3.

**Table II.3 List of Commenters with Written Submissions in Response to the August 2024 NODA**

Commenter(s)	Abbreviation	Comment No. in the Docket	Commenter Type
Stephanie Bice	Bice	95	Individual
Gas Analytics and Advocacy Services	GAAS	96	Advocacy Group
Benjamin Zycher	Zycher	97	Individual
True Manufacturing*	True	98	Manufacturer
Delfield Company	Delfield	99	Manufacturer
James Broughel	Broughel	100	Individual
North American Association of Food Equipment Manufacturers	NAFEM	101	Trade Association
Competitive Enterprise Institute	CEI	102	Advocacy Group
National Association of Home Builders	NAHB	103	Trade Association
Air-Conditioning, Heating, and Refrigeration Institute	AHRI	104	Trade Association
Anonymous*	Individual Commenter	105	Individual
Appliance Standards Awareness Project, American Council for an Energy-Efficient Economy, Northwest Energy Efficiency Alliance	ASAP <i>et al.</i>	106	Efficiency Organizations
Continental Refrigerator	Continental	107	Manufacturer
Husmann	Husmann	108	Manufacturer
The American Lighting Association (ALA); Association of Home Appliance Manufacturers (AHAM); National Electrical Manufacturers Association (NEMA); North American Association of Food Equipment Manufacturers (NAFEM); National Automatic Merchandising Association (NAMA); Plumbing Manufacturers International (PMI); and Power Tool Institute (PTI)	ALA <i>et al.</i>	109	Trade Association
Hillphoenix**	Hillphoenix	110	Manufacturer
ITW Food Equipment Group, - Traulsen	ITW	111	Manufacturer
National Automatic Merchandising Association**	NAMA	112	Trade Association
California Investor-Owned Utilities	CA IOUs	113	Energy Utilities
Zero Zone	Zero Zone	114	Manufacturer
US Chamber of Commerce (USCC), American Coke and Coal Chemicals Institute (ACCI), American Gas	USCC <i>et al.</i>	115	Trade Associations



Association (AGA), American Petroleum Institute (API), American Public Gas Association (APGA), Interstate National Gas Association of America (INGAA), National Automatic Merchandising Association (NAMA), National Rural Electric Cooperative Association (NRECA), North American Association of Food Equipment Manufacturers (NAFEM)			
Joseph Lepak	Lepak	116	Individual
Joseph Lepak	Lepak	117	Individual

\* The commenter submitted only confidential comments

\*\* These commenters submitted confidential comments in addition to public comments

A parenthetical reference at the end of a comment quotation or paraphrase provides the location of the item in the public record.<sup>19</sup>

### 3. Applicability of This Final Rule to Large-Capacity CRE

As discussed in section I of this document, DOE is establishing and amending standards in this final rule for the classes of equipment shown in table I.1. This includes all classes of CRE currently subject to energy conservation standards, and DOE is additionally establishing standards for chef bases or griddle stands. However, DOE is not, at this time, amending standards for large-capacity CRE ranges presented in table IV. for the VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L equipment classes. Large-capacity CRE in these classes would remain subject to the current energy conservation standards applicable to those classes for which compliance was required beginning on March 27, 2017.

DOE has summarized the comments it received in response to the October 2023 NOPR and August 2024 NODA specific to the large-capacity analysis as follows. Zero Zone, ASAP *et al.*, AHRI, and Hussmann commented in support of DOE's decision to separate self-contained units into two groups, and of DOE's updated assumption that larger self-contained equipment will use an A2L refrigerant, such as R-454C, when the refrigeration cooling load of the case

is more than can be achieved using an allowable R-290 charge size. (Zero Zone, No. 114 at p. 1, (ASAP *et al.*, No. 106 at pp. 1–2, AHRI, No. 104 at p. 9, Hussmann, No. 108 at p. 3) Hussmann and AHRI additionally agreed with DOE's finding that compressors using R-454C and R-455A have performance similar to compressors with refrigerants already in use (*e.g.*, R-404A) in larger equipment. (Hussmann, No. 108 at p. 3, AHRI, No. 104 at p. 9) Hillphoenix agreed with DOE's A2L compressor cost assumptions. (Hillphoenix, No. 110 at p. 3). Hussmann, AHRI, and Continental disagreed with DOE's A2L compressor cost assumptions and stated that the price of an A2L compressor is similar to an R-404A compressor at the same cooling capacity. (Hussmann, No. 108 at p. 3; AHRI, No. 104 at p. 9; Continental, No. 107 at p. 2). Hussmann and Due North commented with concerns that large volume units would be susceptible to discontinuation as they face some of the most severe proposed energy use reductions. (Hussmann, No. 80 at p. 7, Due North, No. 87, at pp. 1–2) The CA IOUs recommended that DOE reconsider how it defines 'large' and 'non-large' capacity equipment, and that DOE reconsider its assumption that all 'large' units will require A2L refrigerants. (CA IOUs, No. 113 at p. 4)

For all comments received in response to the October 2023 NOPR and August 2024 NODA, DOE appreciates the comments and continues to analyze the large-capacity ranges presented in table IV.5 for the VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L equipment classes.

Further, DOE is not addressing nor discussing any analytical methodologies or results for the large-capacity ranges of these equipment classes in this

document as DOE continues to consider the comments submitted in response to the October 2023 NOPR and August 2024 NODA.

### III. General Discussion

DOE developed this final rule after considering all oral and written comments, data, and information from interested parties that represent a variety of interests. This document addresses issues raised by these commenters.

#### A. General Comments

This section summarizes general comments received from interested parties regarding rulemaking timing and process.

##### 1. General Support

In response to the October 2023 NOPR, Ravnitzky, ASAP *et al.*, NYSERDA, NEEA and NWPCC, and Killin supported the October 2023 NOPR, citing large national energy savings and considerable savings for businesses. (Ravnitzky, No. 57 at p. 1; ASAP *et al.*, No. 79 at p. 1; NYSERDA, No. 88 at pp. 1–2; NEEA and NWPCC, No. 89 at p. 3; Killin, No. 59 at p. 1) Ravnitzky commented that the proposed rule would have significant environmental and public health benefits and that the net economic benefits for consumers and manufacturers would outweigh the costs of complying with the proposed rule. (Ravnitzky, No. 57 at p. 1)

In response to the October 2023 NOPR, Ravnitzky also commented that the rule creates a level playing field for manufacturers by harmonizing standards across different types and classes of CRE. (Ravnitzky, No. 57 at p. 1) Ravnitzky urged DOE to finalize and implement the rule as soon as possible,

<sup>19</sup> The parenthetical reference provides a reference for information located in the docket of DOE's rulemaking to develop energy conservation standards for CRE. (Docket NO. EERE-2017-BT-STD-0007, which is maintained at [www.regulations.gov](http://www.regulations.gov)). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

while also continuing to monitor and evaluate its impacts and outcomes and to seek feedback and input from stakeholders and experts. (*Id.* at p. 5)

In response to the October 2023 NOPR, NEEA and NWPCC supported the proposal of TSL 5 as it represents the highest standard level that is technically feasible and economically justified and provides a large amount of cost-effective energy savings for the Nation. (NEEA and NWPCC, No. 89 at p. 3)

In response to the August 2024 NODA, ASAP *et al.* supported DOE's updates to the analysis presented in the NODA and believe the updated analysis provides a strong basis for finalizing amended CRE standards, and encourages the adoption of the highest efficiency levels ("ELs") that have positive life-cycle cost savings. (ASAP *et al.*, No. 106 at p. 1) Based on DOE's updated analysis for the NODA, ASAP *et al.* estimated that amended standards meeting this criteria would yield about 1.5 quads of energy savings and up to about \$4.5 billion in net present value savings for purchasers based on DOE's updated analysis for the August 2024 NODA. (*Id.*)

An anonymous commenter expressed general support for adopting the max-tech level. (Anonymous, No. 105 at p. 1)

Lepak commented in support of the rulemaking because, while it may increase costs for consumers, without these regulations innovation would not occur and consumers rely on regulations like this one to ensure that they have access to quality, energy efficient products. (Lepak, No. 116, at p. 1; Lepak, No. 117, at p. 1) Lepak added that energy efficiency measures help the country to meet its climate goals. (*Id.*)

## 2. General Opposition

DOE also received comments, in response to the October 2023 NOPR and the August 2024 NODA, outlining numerous concerns with the proposed new and amended energy conservation standards. These included concerns about other cumulative regulatory changes the industry is currently addressing, including a final rule published by the EPA regarding refrigerant prohibitions in certain equipment, leading to requests to delay the rulemaking and/or extend the compliance date of the proposed standards; questions about the economic justification; technical feasibility and cost-effectiveness of the proposed standards; potential inaccuracies in the supporting analysis; potential issues regarding food safe temperatures; and concerns with certain rulemaking processes, including the public

comment period. These comments are included and discussed throughout section III of this document.

### a. Proposed Compliance Date

In the October 2023 NOPR, DOE estimated the publication of a final rule regarding amended energy conservation standards for CRE in the second half of 2024; therefore, for purposes of the October 2023 NOPR, DOE modeled a 3-year compliance period and 2028 as the first full year of compliance with any amended standards, consistent with the requirements of EPCA (*see* 42 U.S.C. 6313(c)(6)(C)(i)). 88 FR 70196, 70237.

In response to the October 2023 NOPR, FMI and NACS, NAFEM, ITW, and NAMA recommended DOE extend its compliance deadline to 5 years due to the requirements of the AIM Act and the significant investment and redesign associated with the ongoing EPA rulemakings. (FMI and NACS, No. 78 at p. 2; NAFEM, No. 83 at p. 2; ITW, No. 82 at p. 6; NAMA, No. 85 at p. 34)

In response to the August 2024 NODA, NAFEM, NAMA, and Hillphoenix commented in support of additional time for compliance, and suggested a 5 year compliance period. (NAFEM, No. 101 at pp. 4–5; NAMA, No. 112 at p. 3; Hillphoenix, No. 110 at p. 12) In response to the August 2024 NODA, Continental stated that adopting standards with a 3 year compliance period would force them to exit the market for many equipment configurations. (Continental, No. 107 at p. 3) Hoshizaki commented that more than 100 of its CRE models would be affected by the energy conservation standards proposed in the October 2023 NOPR, and corresponding UL safety and NSF sanitation testing will be difficult or impossible to complete within the 3-year compliance period. (Hoshizaki, No. 76 at pp. 6–7)

In response to the October 2023 NOPR, NAMA recommended that DOE increase the time of compliance to recoup investments and alleviate the stress of staffing, supply chain issues, and platform changes to use low GWP refrigerants. (*Id.* at p. 18) NAMA suggested that DOE allow the industry 2–3 years after the effective date of EPA's final rule published in the **Federal Register** on October 24, 2023, to address HFCs through the AIM Act ("October 2023 EPA Final Rule"; 88 FR 73098) to absorb the costs of the refrigerant transition before redesigning their products to the next CRE energy conservation standards. (*Id.* at pp. 19, 27)

DOE acknowledges the concerns raised by manufacturers regarding the cumulative regulatory burden from the

October 2023 EPA Final Rule and DOE energy conservation standards rulemakings, which is compounded by changes to Underwriters Laboratories ("UL") safety standards for the equipment covered by this rulemaking. DOE notes that it has some flexibility under EPCA to delay the effective date of new and amended standards: if the Secretary determines that a 3-year period is inadequate, the Secretary may establish an effective date that would apply to CRE on or after a date that is not later than 5 years after the final rule is published in the **Federal Register**. (See 42 U.S.C. 6313(c)(6)(C)) Based on stakeholder comments and DOE's assessment of the overlapping Federal refrigerant regulations and recent changes to UL safety standards for CRE, DOE is extending the compliance period from the 3-years analyzed in the October 2023 NOPR (modeled as a 2028 compliance year) to 4-years (modeled as a 2029 compliance year) for this final rule.

Generally, DOE understands that aligning compliance dates to avoid multiple successive redesigns can help to reduce cumulative regulatory burden. However, stakeholder comments indicate and make clear that the rulemaking timelines and compliance periods for DOE and EPA regulations make it challenging to redesign and retest CRE simultaneously to meet both the October 2023 EPA Final Rule and new and amended DOE standards. As discussed in more detail in section IV.J.3.c of this document, manufacturers indicated that testing facilities and engineering resources are currently fully consumed by the transition to low-GWP refrigerants and new UL safety standards. Many manufacturers expressed concern that third-party laboratories already have backlogs and are experiencing delays, meaning that requiring new and amended standards for CRE within a short time period could exacerbate the issue. DOE has determined that a 4-year compliance period to redesign CRE to meet the adopted standards will help alleviate manufacturers' concerns about engineering and laboratory resource constraints. Furthermore, the longer compliance period will help mitigate cumulative regulatory burden by allowing manufacturers more flexibility to spread investments across 4 years instead of 3 years. Manufacturers will also have more time to recoup any investments made to redesign CRE to comply with the October 2023 EPA Final Rule as compared to a 3-year compliance period.

Regarding manufacturers' requests to extend the compliance period to 5 years,



DOE notes that much of the CRE market has already transitioned to low-GWP refrigerants and the portion of the market that has not transitioned will likely complete the conversion to low-GWP refrigerants 2 to 4 years prior to when compliance is required for new and amended energy conservation standards. Furthermore, as compared to the October 2023 NOPR, DOE is adopting generally less stringent efficiency levels in this final rule. As such, DOE expects that a 4-year compliance period (compliance with adopted standards required in 2029) provides industry sufficient time to redesign CRE to comply with new and amended standards.

In the notice of proposed rulemaking published in the **Federal Register** on December 15, 2022 (“December 2022 EPA NOPR”), EPA proposed a January 1, 2025, compliance date for the refrigeration categories that apply to CRE. 87 FR 76738, 76773–76774 (Dec. 15, 2022). For self-contained CRE, which account for approximately 86 percent of industry CRE shipments covered by this final rule, the October 2023 EPA Final Rule finalized the compliance date as proposed. 88 FR 73098, 73150. For remote-condensing CRE, which account for the remaining 14 percent of industry CRE shipments covered by this final rule, the October 2023 EPA Final Rule finalized a compliance date of January 1, 2026 or January 1, 2027, depending on the category. *Id.* As discussed in the October 2023 EPA Final Rule, EPA considered updates to UL standard 60335–2–89 and the subsequent incorporation of those updates by electing to extend the compliance dates for many subsectors in retail food refrigeration, including remote-condensing CRE. However, EPA determined that self-contained CRE would not require a delayed compliance date because low-GWP refrigerants such as R–290 have been used in self-contained CRE applications for years, and, therefore, the industry is much further along in the transition to low-GWP refrigerants compared to other refrigeration subsectors. *Id.* at 88 FR 73154. DOE agrees with EPA and notes that it has observed, and manufacturers concur,<sup>20</sup> that a significant number of CRE models have already been transitioned to refrigerants that comply with the October 2023 EPA Final Rule. For example, 93 percent of CRE models currently rated to ENERGY STAR®’s CRE database use either R–290 or R–

600a.<sup>21</sup> This is supported by NAFEM members and CRE industry statements captured in the comments from NAFEM, which stated that “most self-contained CRE today, in the commercial bar space, already uses alternate refrigerants, (almost exclusively R–290),” and “we already made the change to R–290 from R–134a more than 5 years ago.” (NAFEM, No. 83 at pp. 3–5) This demonstrates that data and technology are currently known and available for manufacturers to understand performance impacts of this refrigerant transition.

As previously mentioned, compared to the October 2023 NOPR, DOE is adopting generally less stringent efficiency levels (in terms of percent energy use below the analyzed baseline) for 22 out of the 28 directly analyzed equipment classes. DOE notes that there were several changes made to the analysis in response to comments and data submitted on the October 2023 NOPR and the August 2024 NODA that resulted in DOE adopting generally less stringent standards, including but not limited to, the updates made to single-speed and variable-speed compressors, screening out design options such as evaporator fan controls and microchannel condensers, and updated baseline design options. Due to these updates and other considerations detailed throughout this final rule, DOE is adopting generally less stringent standards than the standards proposed in the October 2023 NOPR. As such, DOE expects fewer CRE models would require redesign to meet the levels adopted in this final rule compared to the levels proposed in the October 2023 NOPR. For example, DOE estimated that approximately 11 percent of shipments would meet the proposed TSL in the October 2023 NOPR by the analyzed compliance date. Comparatively, DOE estimates that approximately 49 percent of shipments would meet the TSL adopted in this final rule by the analyzed compliance date. Furthermore, DOE expects that the investment and redesign effort required to meet the adopted standards would be lower since fewer models would require redesign at the adopted standard level.

As permitted under EPCA and discussed in the preceding paragraphs, DOE is extending the compliance period from the three years analyzed in the October 2023 NOPR (modeled as a 2028 compliance year) to four years (modeled as a 2029 compliance year) for this final rule. (See 42 U.S.C. 6313(c)(6)(C))

<sup>21</sup> See [www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results](http://www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results) (last accessed Oct. 23, 2024).

## b. Proposed Standards

In response to the October 2023 NOPR, FMI and NACS commented that the proposed energy conservation standards are neither required nor justified under EPCA. (FMI and NACS, No. 78 at p. 2) FMI and NACS commented that DOE has not adequately demonstrated that these standards would be technologically feasible and cost-effective, adding that, in many cases, the proposed standards would require design elements and technology that is not economically justified or technically feasible. (*Id.*) FMI and NACS commented that DOE significantly underestimates the costs of compliance with the proposed rule and provided an example that one FMI member’s analysis showed an increased case cost of 20–25 percent to comply with the proposed rule as well as more difficult and costly servicing. (FMI and NACS, No. 78 at p. 4). FMI and NACS commented that with more accurate cost and benefit information, it is likely that DOE’s rebuttable payback period analysis will result in much longer payback periods. (*Id.*)

In response to the comments from FMI and NACS, DOE notes that for the proposed levels in the October 2023 NOPR, the analyzed cost increases were consistent with FMI and NACS’ comment (*i.e.*, up to the 20 to 25 percent increase), thus it is not clear that there is a disconnect on technologies required to get to the proposed levels. DOE further notes that the finalized standard levels presented in this final rule (*i.e.*, TSL 3) are generally less stringent and the cost increases to attain the finalized levels are less, on average, than the levels proposed in the October 2023 NOPR and were determined to be cost-effective. DOE further notes that in its analysis, the servicing costs were set proportional to the equipment cost (*i.e.*, higher cost for more efficient equipment—see section IV.F.5 of this document and chapter 8 of the final rule TSD for more details on these costs).

An anonymous commenter stated that the cost benefits of the October 2023 NOPR are inflated by the assumption of social and health benefits, which are speculative, and added that higher costs from the October 2023 NOPR will render CRE unaffordable for consumers and industry. (Anonymous, No. 73 at p. 1)

In response to the anonymous commenter, DOE notes that the October 2023 NOPR stated that the estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a

<sup>20</sup> See Storemasters, No. 68 at pp. 1–2.

proposed standard level is economically justified. See 88 FR 70196, 70292.

In response to the August 2024 NODA, Bice commented that she opposes the October 2023 NOPR, citing concerns with the multitude of proposals being published by the DOE. (Bice, No. 92 at p. 1) Bice commented also that these proposals are adding burdensome energy conservation standards to products that Americans use on a regular basis. (*Id.*) Bice stated her belief that the proposed standards would increase production costs for manufacturers and retail prices for consumers and small businesses, costing millions of dollars with few long-term benefits. (*Id.*) Bice commented that past rules published by the DOE are an unnecessary overreach of the Federal government, and that these regulations limit consumer choice, drive up prices, and impose onerous regulations on American manufacturers, many of whom being small businesses. (*Id.*)

In response to Bice, as discussed in section II.A of this document, EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment; this equipment includes commercial refrigerators, freezers, and refrigerator-freezers. (42 U.S.C. 6291–6317, as codified; 42 U.S.C. 6311(1)(E)) EPCA also includes a lookback period which directs DOE to conduct future rulemakings to determine whether to amend standards not later than six years after the issuance of any final rule establishing or amending a standard. (42 U.S.C. 6313(c)(6); 42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(1)) DOE notes that as compared to the October 2023 NOPR, DOE is extending the compliance period from the three years analyzed in the October 2023 NOPR to four years for this final rule, which would allow manufacturers an additional year to redesign equipment and comply with the new or amended standards. Additionally, as discussed in III.A.2.a of this document, DOE is adopting generally less stringent standards than what DOE proposed in the October 2023 NOPR. DOE discusses the benefits and burdens of each TSL considered in section V.C of this document. Regarding the impacts to small businesses, DOE analyzes the impacts to small business consumers in section V.B.1.b of this document and small business manufacturers in section VI.B of this document.

In response to the August 2024 NODA, Zycher commented that energy savings analyzed as a result of the proposed standards are about 2 tenths of one percent of the energy consumed in

2023 by the residential, commercial, and industrial sectors and are trivial. (Zycher, No. 97 at p. 3) Zycher further commented that, accordingly the reduction in GHG emissions and resulting decline in global temperatures are negligible. (*Id.* at pp. 3–4)

In response to Zycher's comment, DOE notes that CRE are one of many regulated products and equipment within DOE's authority to set efficiency standards, and that the appliance standards program has helped the United States avoid 2.6 billion tons of carbon dioxide emissions.<sup>22</sup> Additionally, DOE notes that the energy savings analyzed as a result of new and amended standards in this final rule are compared to the overall energy use of the CRE market, not the overall energy consumed by the residential, commercial, and industrial sectors.

In response to the October 2023 NOPR and the August 2024 NODA, commenters expressed concern regarding the stringency of proposed standards, requesting no-new standards or alternate levels, citing technological feasibility, and expressing concern about equipment elimination, as discussed in the following sections.

#### No-New-Standards

In response to the October 2023 NOPR and August 2024 NODA, Storemasters, Kirby, Continental, NAFEM, Hoshizaki, ITW, AHRI, NAMA, and Hussmann recommended that DOE issue a no-new-standards rule at this time. (Storemasters, No. 68 at p. 2; Kirby, No. 66 at p. 2; Continental, No. 86 at p. 7; NAFEM, No. 83 at p. 2; NAFEM, No. 101 at p. 5; Hoshizaki, No. 76 at p. 1; ITW, No. 82 at p. 1; AHRI, No. 81 at p. 5; NAMA, No. 112 at p. 3; Hussmann, No. 80 at p. 13)

In response to the August 2024 NODA, Continental stated that while the August 2024 NODA revises some analysis and provides support documents, it does not provide updated standards levels, and Continental could not adequately conclude whether the updated determinations are sufficient to establish proposed energy standards that are technologically feasible and economically justified. (Continental, No. 107 at p. 3) Continental stated its understanding that DOE has statutory obligations and a court mandate however requests DOE not rush into adopting more stringent standards, and leave new energy savings for future rulemakings. (*Id.*)

AHRI commented that no significant technologies have been developed since

2017 to bring about the additional energy efficiency that DOE expects in the October 2023 NOPR. (AHRI, No. 81 at p. 11) AHRI commented that a no-new-standards rule would allow time to collect data on products in the market, evaluate safety mitigation measures associated with the refrigerant transition, reduce the burden on manufacturers and end-users, and increase time for product re-design. (*Id.*)

In response to the October 2023 NOPR, ITW stated that a “no new standards” decision at this time would give the industry and DOE time to work together on analyzing the correct data and new data for the new categories for which DOE has proposed energy use multipliers. (ITW, No. 82 at p. 6)

In response to the October 2023 NOPR, notwithstanding Hussmann's comments regarding both a pause in the rulemaking and timing of the rulemaking, Hussmann commented that while it requests that DOE impose no new standards, the focus should not be on timing but rather on the proposed energy limits themselves being unachievable. (Hussmann, No. 80 at p. 13)

Hussmann commented that they are currently amending to the UL/CSA 60335–1 and 60335–2–89 standards, which consumes laboratory resources, space, and time. (Hussmann, No. 108 at p. 2). Hussmann asserted that this shift requires new design modifications and the addition of new components, which may take 1–3 years of laboratory time to fulfill. (*Id.*) Hussmann stated that this limits their ability to fulfill new DOE requirements. (*Id.*) Hussmann stated that there is significant benefit to all stakeholders, the retailers, as well as the consumer to abstain from additional DOE energy efficiency regulation at this time. (*Id.*)

In response to the August 2024 NODA Zycher commented that the CRE standards analyzed in the August 2024 NODA are flawed and should not be finalized. (Zycher, No. 97 at p. 10)

With regard to stakeholders' request for DOE to adopt a “no-new-standards” determination to allow industry additional time to analyze data related to the proposed energy use multipliers, DOE notes that manufacturers and other commenters were provided with an additional opportunity to provide feedback on the updated results presented in the August 2024 NODA, which offered manufacturers approximately eight months after the October 2023 NOPR comment period ended to analyze data related to the proposed energy use multipliers. In response to Continental's comment about not having a proposed standard

<sup>22</sup> See [www.energy.gov/eere/buildings/about-appliance-and-equipment-standards-program](http://www.energy.gov/eere/buildings/about-appliance-and-equipment-standards-program).



level in the August 2024 NODA, DOE notes that while one specific standard level was not proposed in the August 2024 NODA, standard equations at each efficiency level were presented in the August 2024 NODA. The August 2024 NODA provided stakeholders an additional opportunity to comment on the revisions to the analysis from the October 2023 NOPR, and the revised relationships between design, cost, and efficiency that were the basis of DOE's analysis leading to the standards established and amended in this final rule. Furthermore, EPCA specifies that any new or amended energy conservation standard that DOE adopts for any type (or class) of covered equipment must be designed to achieve the maximum improvement in energy efficiency that the Secretary determines is technologically feasible and economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(A)) As discussed in section V.C of this document, DOE has determined that TSL 3 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. However, DOE notes that, as discussed in section III.A.2.a of this document, DOE is extending the compliance period from the 3-years analyzed in the October 2023 NOPR to 4-years for this final rule to mitigate concerns of commenters about cumulative regulatory burden and associated engineering and laboratory resource constraints, which have been exacerbated by the ongoing refrigerator transition in response to the October 2023 EPA Final Rule and updated safety standards (*e.g.*, UL 60335-2-89).

#### Requested Alternate Levels

In response to the October 2023 NOPR, Continental commented that if a no-new-standards determination is not possible, DOE should publish new standards levels that align with the ENERGY STAR Product Specification for Commercial Refrigerators and Freezers Version 5.0, which will provide energy reductions at levels that have been substantially evaluated by stakeholders. (Continental, No. 86 at p. 7)

In response to the October 2023 NOPR and the August 2024 NODA, Delfield commented that, while it is reasonable for DOE to push regulations toward the ENERGY STAR version 5.0 levels,<sup>23</sup> in general, DOE should limit reductions to no more than 20 percent compared to

2017 DOE levels. (Delfield, No. 71 at p. 1; Delfield, No. 99 at p. 1)

DOE appreciates the feedback from Continental and Delfield, and notes that out of the 11 ESTAR equipment classes analyzed in this final rule, the amended standards for 8 classes are at similar or less stringent levels than ENERGY STAR version 5.0 levels. In addition, in this final rule, of the 49 equipment classes analyzed, 28 equipment classes did not have greater than 20 percent energy use reduction from the current standard, as suggested by Delfield, and 36 equipment classes did not have greater than 20 percent energy use reduction from the baseline analyzed in this final rule. However, DOE disagrees that all equipment classes should align with these comments. All results of this analysis are based on DOE's final rule analysis, which shows that for 22 equipment classes, energy conservation standards more stringent than ENERGY STAR or 20% reduction from the current standard are technologically feasible and economically justified. For the full list of cost-efficiency results, see chapter 5 of the final rule TSD.

In response to the August 2024 NODA, the CA IOUs commented that DOE should set standards at the highest EL with positive LCC savings for all equipment classes for the final rule. (CA IOUs, No. 113 at p. 6)

As discussed in section III.F of this document, the potential impacts to individual consumers such as the changes in LCC and PBP associated with new or amended standards is one aspect of the seven factors that DOE evaluates when determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) As discussed in section V.C of this document, DOE has determined that TSL 3 represents the maximum improvement in energy efficiency that is technologically feasible and economically justified. DOE has determined that establishing standards at TSL 3 balances the benefits of the energy savings and impacts to consumers at TSL 3 with the potential burdens placed on CRE manufacturers. DOE notes that at TSL 3, affected purchasers for each CRE equipment class experience an average LCC savings ranging from \$8 to \$1,868 with a payback period ranging from 0.9 years to 7.0 years. Overall, approximately 91 percent of affected CRE purchasers would experience a net benefit or not be affected at TSL 3.

#### Technological Feasibility

In response to the October 2023 NOPR, Hoshizaki, ITW, SCC, and

NAFEM commented that the proposal is not technologically feasible or economically justified, and that many technologies analyzed are already in use. (Hoshizaki, No. 76 at pp. 1, 3; ITW, No. 82 at p. 1; SCC, No. 74 at p. 1; NAFEM, No. 83 at p. 2)

Hoshizaki commented that the proposed energy standards would require over 30-percent reductions to meet the amended standards—VCS.SC.M, VCT.SC.M, VCS.SC.L, SOC.SC.M, and classifications with RT, PT, and RI doors. (Hoshizaki, No. 76 at p. 3)

In response to the October 2023 NOPR, Due North generally supported the October 2023 NOPR but expressed concern regarding the severe reductions of the proposed conservation standards to VCT.SC.L, VCT.SC.M, VOP.SC.M, VCT.SC.M.PT, and VCT.SC.M.SDPT equipment classes. (Due North, No. 87 at pp. 1–2) Due North commented that, based on its analysis, the proposed energy conservation standards would reduce the current threshold levels for VCT.SC.L by 19 percent, VCT.SC.M by 17–41 percent, depending on the unit refrigerated volume, and VOP.SC.M by 26 percent. (*Id.* at p. 1) Due North stated that these reductions are severe and hard to achieve using present energy-saving technologies such as variable-speed compressors, electronically commutated fan motors, adaptive defrosts, efficient light-emitting diode (“LED”) lighting, and smart controls. (*Id.*)

In response to the October 2023 NOPR, Hussmann stated that DOE's proposed energy limits, that are up to 70 percent less than the current DOE standard levels, are unattainable for Hussmann products. (Hussmann, No. 80 at p. 6) Hussmann additionally commented that other Hussmann models would be required to meet 20-to-40-percent drops in energy limits while already using electronically commutated motors (“ECMs”), LED lights, and optimized air curtains/doors and insulation, and, in the face of these unattainable limits, Hussmann would need to weigh the benefits between feasibility, increased cost, development time, and consumer interest with the decision to discontinue certain product lines entirely. (*Id.* at pp. 6–7)

In response to the October 2023 NOPR, Storemasters and FMI and NACS stated their concern with the proposed changes set forth in the October 2023 NOPR on the grounds that DOE has overestimated the energy efficiency benefits of its proposed rule because manufacturers may stop offering certain cases in order to comply with the proposed standards. (Storemasters, No.

<sup>23</sup> Available at: [www.energystar.gov/products/spec/commercial\\_refrigerators\\_and\\_freezers/specification\\_version\\_5\\_0\\_pd](http://www.energystar.gov/products/spec/commercial_refrigerators_and_freezers/specification_version_5_0_pd) (last accessed October 3, 2024).

68 at p. 1; FMI and NACS, No. 78 at p. 4).

In response to the comments from Hoshizaki, ITW, SCC, NAFEM, Due North, Hussmann, and FMI and NACS, DOE notes that, in this final rule, it updated its October 2023 NOPR engineering analysis based on testing conducted, teardowns conducted, and stakeholder feedback received since the October 2023 NOPR, including comments received from Hoshizaki, ITW, SCC, NAFEM, Due North, Hussmann, and FMI and NACS. Furthermore, as compared to the October 2023 NOPR, DOE is adopting generally less stringent efficiency levels in this final rule.

NAFEM indicated its belief that DOE has made high-level changes from the October 2023 NOPR to the August 2024 NODA and did not clearly explain what changes result from the changes made, and if they resolve the issues which were present in the October 2023 NOPR. (NAFEM, No. 101 at p. 2)

In response to the comment from NAFEM, DOE notes that the engineering changes from the October 2023 NOPR to August 2024 NODA were explained in section II.A of the August 2024 NODA and are further detailed in section IV.C.1.a.iii of this document. 89 FR 68788, 68790–68794. For example, in section II.A.3.a of the August 2024 NODA on evaporator fan controls, DOE explained that “recognizing current uncertainty as to whether such food safety requirements could be maintained in certain applications of self-contained, closed CRE with the use of evaporator fan controls, DOE has tentatively screened out evaporator fan control as a design option for CRE. As a result, this NODA presents an updated engineering analysis that does not include evaporator fan control as a design option.” 89 FR 68788, 68793.

In this final rule analysis, DOE is adopting TSL 3. DOE discusses the benefits and burdens of each TSL considered and DOE’s conclusion in section V.C of this document. As discussed in that section, TSL 3 represents the maximum energy savings that are technically feasible and economically justified, as required by EPCA.

#### Food Safety

In response to the October 2023 NOPR, Hillphoenix, NAMA, and NAFEM stated that most CRE are certified to National Sanitation Foundation (“NSF”) 7 for food safe storage, which is required by U.S. and Canadian food safety standards and local health codes. (Hillphoenix, No. 77 at p. 3; NAMA, No. 85 at p. 16; NAFEM,

No. 83 at pp. 10–11) ITW and NAFEM commented that to meet the energy efficiency standard proposed in the October 2023 NOPR, equipment would require design downgrades that would make it unable to consistently meet food safety standards, in which safe operating temperatures are required to be between 33 °F and 40 °F inside the cabinet. (ITW, No. 82 at p. 6; NAFEM, No. 83 at p. 10) NAMA requested that design options be reviewed not only for their efficiency but also for the ability to maintain food safe performance. (NAMA, No. 85 at p. 16) ITW added that the proposed levels threaten to mandate equipment that cannot keep food at safe temperatures. (ITW, No. 82 at p. 1)

In response to the October 2023 NOPR, FMI and NACS commented that, according to their members, the October 2023 NOPR does not evaluate the potential impact of the standards on food safety, because CRE that meet the proposed standards may be unable to consistently meet the refrigeration necessary to meet food safety standards. (FMI and NACS, No. 78 at p. 3)

In response to the October 2023 NOPR, NAFEM commented that DOE’s proposed energy limits would likely force manufacturers to make the choice between a DOE-compliant product with a smaller refrigeration system and a product designed with adequate capacity to maintain food safety in the many different environmental conditions and general product conditions. (NAFEM, No. 83 at p. 11)

In response to the October 2023 NOPR and the August 2024 NODA, Hillphoenix suggested that DOE should categorize different CRE products based on the type of product or food displayed, and in the August 2024 NODA stated that current energy limits for CRE displaying perishable food products are too difficult to obtain while meeting NSF 7. (Hillphoenix, No. 77 at p. 3 and No. 110 at p. 2) In response to the October 2023 NOPR, Hillphoenix also commented that bottle coolers operate at warmer temperatures than CRE displaying perishable products, in order to maintain product temperatures at 41 °F or less, but both have the same energy limits established by a single equipment class. (Hillphoenix No. No. 77 at p. 3)

In response to the October 2023 NOPR, Ravnitzky commented that the October 2023 NOPR should consider the impacts of energy efficiency standards on food quality and safety and balance the benefits of energy savings with the costs of food loss and waste. (Ravnitzky, No. 57 at p. 3)

In response to comments about reviewing design options for efficiency

but also for the ability to maintain food safe performance, and accounting for food loss and waste, DOE notes that in this final rule, consistent with the August 2024 NODA, DOE screened out evaporator fan controls after review of NSF 7 and other public comments stating that evaporator fan controls could potentially lead to internal case temperatures outside of NSF 7 tolerances, as further discussed in section IV.B.1.f. DOE has reviewed all design options analyzed to improve efficiency in this final rule and has determined, based on data and information available to DOE at the time of this final rule, that all other design options analyzed to improve efficiency would not affect the ability of CRE equipment to maintain food safe temperatures.

In response to Hillphoenix’s comment regarding categorizing different CRE equipment based on the type of product or food displayed, DOE notes that the CRE equipment classes do differentiate between frozen merchandise (*i.e.*, low-temperature freezers and ice-cream freezers) and refrigerated merchandise (*i.e.*, medium-temperature refrigerators and high-temperature refrigerators).

In response to Hillphoenix’s comment regarding bottle coolers operating at warmer temperatures than CRE displaying perishable products, DOE notes that all equipment certified to an equipment class must test their equipment according to the rating temperature for that equipment class, unless the equipment meets the definition of lowest application product temperature. See 10 CFR 431.62.

#### Equipment Elimination

In response to the October 2023 NOPR, SCC and NAFEM expressed concern that the October 2023 NOPR proposed standard level would force manufacturers to discontinue products or exit the CRE space. (SCC, No. 74 at p. 4; NAFEM, No. 83 at p. 2) NAFEM and Continental added this would harm consumers, reduce competition, and may increase energy consumption. (NAFEM, No. 83 at p. 2; Continental, No. 86 at p. 6)

In response to the October 2023 NOPR, Due North commented that it still found the energy standards for the VCT.SC.M.PT and VCT.SC.M.SDPT classes to be too stringent, given their extensive installation at store checkout counters. (Due North, No. 87 at p. 2) Due North called this situation a potential threat to the future existence of these classes on the market. (*Id.*)

With respect to these comments regarding the stringency of the proposed standards in the October 2023 NOPR



and the equipment modifications needed to meet those standards, pursuant to EPCA, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically feasible and economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(A)) In the October 2023 NOPR, DOE tentatively determined that TSL 5 represented the maximum improvement in energy efficiency that is technologically feasible and economically justified and to establish new energy conservation standards for covered equipment not yet subject to energy conservation standards. 88 FR 70196, 70197. In response to the October 2023 NOPR, DOE received feedback from commenters suggesting changes to the October 2023 NOPR analysis. After consideration of this feedback and a review of new test data, in this final rule, DOE has adjusted certain aspects of the October 2023 NOPR analysis approach. In this final rule, DOE is adopting new and amended energy conservation standards (*i.e.*, TSL 3) that DOE has determined represent the maximum improvement in energy efficiency that is technologically feasible and economically justified based on the numerous revisions to inputs and the analysis, resulting in revised analytical outputs since the October 2023 NOPR, discussed throughout section IV of this final rule. Further detail on changes to the engineering analysis from the October 2023 NOPR can be found in section IV.C of this document.

As stated, in the preceding paragraphs, the results presented in this final rule are generally less stringent than the standards proposed in the October 2023 NOPR. In the October 2023 NOPR, the PT and SDPT multiplier values were 1.04 and 1.11 respectively. 88 FR 70196, 70231. In the August 2024 NODA, DOE analyzed a single multiplier with value of 1.07. 89 FR 68788, 68794. In this final rule, consistent with the August 2024 NODA, DOE is analyzing equipment classes with features that allow for higher energy use. As discussed further in section IV.C.1.c of this document, the adjusted maximum daily energy use equation for equipment classes with features is equal to 1.07 multiplied by the corresponding equipment class equation (adjusted for backsliding if needed). Although the multiplier analyzed in this final rule is less than that in the October 2023 NOPR for the SDPT multiplier, at the representative capacity the amended standard for

VCT.SC.M with feature is 24.8 percent less stringent than the VCT.SC.M.PT equation and 18.3 percent less stringent than the VCT.SC.M.SDPT equation proposed in the October 2023 NOPR.

Hussmann commented that, several of its models would be required to meet energy levels with energy use reductions up to 40 percent compared to 2017 DOE levels, and that Hussmann already put in work to meet the 2017 limits, limiting its ability to further improve energy consumption. (Hussmann, No. 80 at p. 10) Hussmann commented that if reduced energy limits reduce door and lighting options available for case energy performance, it will delay the conversion and prolong the use of open cases using far more energy than saved by tighter limits on door cases, leading to the obsolescence of some VCT equipment and driving customers to substitute products in the VOP classes that consume more energy, and Hussmann provided a table with additional detail. (*Id.* at pp. 10–11) Hussmann commented also that it has been continuously innovating for years due to marketplace demand. (*Id.* at p. 11) Hussmann pointed to a graph depicting its highest-volume dairy case from 1985 to 2023 and indicating that energy consumption has been reduced by 46 percent over the time period. (*Id.* at p. 12)

In response to the comment from Hussmann regarding door and lighting technology, DOE notes that the screening criteria in IV.B of this document screens out any technology options that are determined to have “a significant adverse impact on the utility of the equipment to subgroups of consumers, or result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time.” See section IV.B of this document for more details. Further, in response to Hussmann’s comment regarding their efficiency improvements, DOE notes that the typical new consumer refrigerator uses one-quarter the energy than in 1973, despite offering 20 percent more storage capacity and being available at half the retail cost since EPCA was established in 1975, showing that there could be more potential savings than already achieved for the example cited by Hussmann.<sup>24</sup>

NAMA recommended that DOE champion and celebrate the changes

that the industry has been making toward energy efficiency and reduce the demands to make additional changes. (NAMA, No. 85 at p. 9) NAMA commented that manufacturers have made changes that have further-reaching, more immediate impacts on energy efficiency than the design options being shown in the engineering analysis in the October 2023 NOPR TSD. (*Id.*) NAMA commented that the industry would appreciate some acknowledgement of these improvements over the past 10 years. (*Id.*)

Kirby stated that changes made to comply with energy conservation standards and low-GWP HFC restrictions that went into effect in 2017 have led to price increases. (Kirby, No. 66 at pp. 1–2)

In response to the August 2024 NODA, Storemasters commented that equipment manufacturers have already made significant changes to equipment to comply with the 2017 standards and much of the current equipment incorporates new refrigerants, particularly self-contained models that utilize R–290. (Storemasters, No. 68 at p. 1)

In response to NAMA’s, Kirby’s, and Storemasters’ comments about the industry improvements over the past 10 years (*i.e.*, since the publication of the March 2014 Final Rule), DOE does acknowledge that in response to the March 2014 Final Rule, manufacturers generally made several changes: changing from fluorescent to LED lighting; updating compressors to either higher efficiency compressors using HFC refrigerants, or compressors using hydrocarbon refrigerants; improved evaporators and condensers; and, in some cases, higher-efficiency fan motors. These changes are acknowledged in the October 2023 NOPR and August 2024 NODA as DOE updated the baseline design specifications and costs for each “primary equipment class” (*i.e.*, directly analyzed class, see IV.C.1 for further description) based on test data, manufacturer feedback, and publicly available market data (*e.g.*, spec sheets). See 88 FR 70196, 70225–70231, 89 FR 68788, 68792.

Kirby and Storemasters commented that additional equipment modifications to meet the proposed standards in the October 2023 NOPR would represent a significant burden on their business because of increased equipment complexity and costs coupled with the potential for reduced equipment reliability, longevity, and consumer choice. (Kirby, No. 66 at p. 2, Storemasters, No. 68 at p. 1)

<sup>24</sup> See [www.energy.gov/eere/buildings/articles/appliance-and-equipment-standards-fact-sheet](https://www.energy.gov/eere/buildings/articles/appliance-and-equipment-standards-fact-sheet).

Storemasters also stated that the new CRE it purchases includes significant changes over the past 6 years to comply with the 2017 standards and low-GWP HFC restrictions. (Storemasters, No. 68 at p. 1)

An individual commenter further expressed concern with the new technologies, stating components necessary to achieve the proposed standards add cost, complexity to the designs, and result in limiting availability and extended lead times. (Individual Commenter, No. 70 at p.1)

In response to the comments from Kirby and Storemasters, DOE notes that the commenters did not specify what design options may reduce equipment reliability. DOE screens out technology options that would result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time.

In response to the comments from Kirby, Storemasters, and an individual commenter regarding the potential for reduced equipment longevity and consumer choice due to increased complexity, DOE is not aware of any data on how the analyzed design options affect equipment lifetime and consumer choice for consumers. See section IV.B of this document for additional information on the screening analysis and section IV.F.6 for a discussion on CRE lifetime.

In response to the individual commenter regarding limiting availability and extended lead times, DOE notes that the screening analysis screens out any technology options that result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time. See section IV.B of this final rule.

#### c. Rulemaking Process

In response to the October 2023 NOPR, NAMA commented that while it appreciates DOE's willingness to schedule face-to-face meetings on these important rulemakings, questions posed by industry representatives during the November 2023 Public Meeting went largely unanswered by DOE and DOE consultants beyond providing information already provided in the October 2023 NOPR TSD or the October 2023 NOPR. (NAMA, No. 85 at p. 4) NAMA further commented that when industry broached many of these issues

at the November 2023 Public Meeting, DOE read prepared answers but did not answer the original questions. (*Id.*)

NAMA stated that there does not appear to have been any contact between DOE consultants and its manufacturing members. (*Id.* at p. 6) NAMA commented that there are no records of manufacturer interviews, no record of emails exchanged, and no attempts made to contact these companies. (*Id.*) NAMA commented also that if DOE had conferred with manufacturers, it is more likely that the information in the October 2023 NOPR TSD would be closer to accurate information and more reflective of today's market. (*Id.* at p. 6)

Husmann recommended that, in future rulemakings, DOE engage manufacturers, component suppliers, retailers, and other stakeholders early in the process, because Husmann alleged their equipment has already implemented available technologies, which yielded slight returns in energy savings with excessive cost. (Husmann, No. 80 at p. 15)

In response to the August 2024 NODA, NAMA added that DOE turned down its offer to work with them and DOE did not substantially change the NODA support document based on NAMA's comments on the October 2023 NOPR TSD. (NAMA, No. 112 at p. 3, 7)

In response to the comment from NAMA about the November 2023 Public Meeting, DOE responded to all questions asked during the November 2023 Public Meeting to the best of its ability. (See November 2023 Public Meeting Transcript, No. 64). In response to the comment from NAMA regarding contact with its manufacturing members and the comment from Husmann about engaging manufacturers, as stated in the October 2023 NOPR, DOE's contractors reached out to a range of representative manufacturers and conducted formal manufacturer interviews with nine manufacturers (representing approximately 60 percent of industry CRE shipments) in advance of the October 2023 NOPR. 88 FR 70196, 70251. During that process, DOE's contractors reached out to NAMA to inquire about its members' interest in participating in formal manufacturer interviews under a nondisclosure agreement but did not receive a response from NAMA. After the October 2023 NOPR was published, DOE held the November 2023 Public Meeting to receive comment on the standards proposed in the October 2023 NOPR and associated analyses and results. DOE has engaged with manufacturers through the rulemaking process, including hosting two Ex Parte meetings

with AHRI, NAMA, and NAFEM; the first on Friday, January 27, 2023,<sup>25</sup> and the second on Monday, September 16, 2024,<sup>26</sup> and the October 2023 NOPR, the November 2023 Public Meeting, and the August 2024 NODA provided opportunity for NAMA and its members to provide comment, data, and information on the proposals and supporting analyses.

The CA IOUs recommended that DOE consider an informal or abbreviated negotiation to maximize energy savings for this rulemaking. (CA IOUs, No. 84 at pp. 6–7) The CA IOUs commented that they will support this rulemaking process by submitting test data for chef bases or griddle stands and high-efficiency, vertical, self-contained equipment in early 2024 and that the CA IOUs plan to send test results for prep tables to help DOE establish energy conservation standards for this equipment class in future rulemakings. (*Id.* at p. 7) In the November 2023 Public Meeting, Continental and NAFEM recommended that there be continued dialogue between DOE and stakeholders concerning energy efficiency standards for CRE. (November 2023 Public Meeting Transcript, No. 64 at pp. 150, 152) Hoshizaki similarly requested negotiations with DOE to find realistic energy savings for this rulemaking. (*Id.* at p. 21)

In response to the comments from the CA IOUs, Continental, NAFEM, and Hoshizaki, DOE appreciates the recommendation but has not pursued a negotiation for this rulemaking. Additionally, DOE welcomes test data for any equipment category, including chef bases or griddle stands; buffet tables or preparation tables; or high-efficiency, vertical, self-contained equipment, submitted by the CA IOUs or any other stakeholder for consideration in future rulemakings.

Continental commented that the proposed rulemaking will have a major impact on its business and pointed out that section 3(a) of 10 CFR part 430, subpart C, appendix A ("Process Rule") specifies a 75-day comment period while DOE is providing only 60 days—which is insufficient for a small business like Continental to review the October 2023 NOPR, the 567-page October 2023 NOPR TSD, and the many other supporting documents. (Continental, No. 86 at pp. 1–2) Continental commented also that DOE deviated from the requirement in the Process Rule that the amended test

<sup>25</sup> See [www.regulations.gov/document/EERE-2017-BT-STD-0007-0050](https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0050).

<sup>26</sup> See [www.energy.gov/gc/ex-parte-communications](https://www.energy.gov/gc/ex-parte-communications).



procedures be finalized at least 180 days prior to the close of the comment period for the October 2023 NOPR, instead providing an interval of 76 days for review and evaluation prior to the deadline of the comment period, which Continental stated is insufficient. (*Id.* at pp. 2–3)

In response to the comment from Continental, DOE notes that the current Process Rule at Section 6(b)(2) specifies that there will be not less than 60 days for public comment on the NOPR, which is consistent with the comment period in the October 2023 NOPR. This 60-day period is also consistent with EPCA requirements. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(p)). Further, the October 2023 NOPR stated that given that the analysis presented in the NOPR remained largely the same as the June 2022 Preliminary Analysis, and in light of the 45-day comment period DOE had already provided with the July 2021 RFI and the 60-day comment period DOE had already provided with its June 2022 Preliminary Analysis, DOE determined that a 60-day comment period was appropriate and provided interested parties with a meaningful opportunity to comment on the proposed rule. 88 FR 70196, 70205. DOE appreciates the considerable volume of comments and information it received in response to the October 2023 NOPR and the August 2024 NODA, which contributed to significant revisions to the final rule analysis and aided in DOE's ability to establish efficiency levels that would be technologically feasible and economically justified.

DOE also notes that, in the October 2023 NOPR, DOE initially determined that the requirement that the amended test procedures be finalized at least 180 days prior to the close of the comment period for the October 2023 NOPR was sufficiently met because, for the equipment whose measured energy use was impacted by the CRE test procedure final rule (“September 2023 Test Procedure Final Rule”; 88 FR 66152 (Sept. 26, 2023)), the CRE industry has thoroughly vetted both Air Conditioning, Heating, and Refrigeration Institute (“AHRI”) 1200–2023 and the proposed addendum B to American Society of Heating, Refrigerating and Air-Conditioning Engineers (“ASHRAE”) 72–2022. *Id.* at 88 FR 70205. Additionally, DOE believes that stakeholders have had sufficient time for review and evaluation of the September 2023 Test Procedure Final Rule, especially because commenters had an additional opportunity to provide comment on this rulemaking through the August 2024 NODA, which was published more than 180 days after

the publication of the September 2023 Test Procedure Final Rule.

#### Rulemaking Timeline

In response to the October 2023 NOPR, ITW commented that if DOE cannot issue a “no new standards” ruling, DOE should extend the review period by 1 year to allow for sufficient time for manufacturers to conduct verification tests to validate the proposed energy standards for the various new equipment categories with different door characteristics and to provide informed comments to DOE. (ITW, No. 82 at p. 2)

Hussmann, Hillphoenix, NAFEM, FMI and NACS, and Hoshizaki requested a pause in DOE rulemakings due to the requirements of the AIM act and other new regulations (Hussmann, No. 80 at p. 1; Hillphoenix, No. 77 at p. 2; NAFEM, No. 83 at p. 26; FMI and NACS, No. 78 at pp. 2–3; Hoshizaki, No. 76 at p. 1) In response to the August 2024 NODA, Hillphoenix commented requesting a pause in rulemakings for CRE given the ongoing efforts to transition to new refrigerants, pursuant to the AIM Act. (Hillphoenix, No. 110 at p. 2) In response to the October 2023 NOPR, Hoshizaki, SCC, AHRI, ITW, NAFEM, and Hussmann commented that a delay in the rulemaking would allow additional time for manufacturers to complete the transition to low-GWP refrigerants (Hoshizaki, No. 76 at pp. 1–2, 7; SCC, No. 74 at p. 2; AHRI, No. 81 at p. 5; ITW, No. 82 at p. 1; NAFEM, No. 83 at p. 26; Hussmann, No. 80 at pp. 6–7, 10)

In response to comments requesting that DOE pause or delay the rulemaking, DOE is statutorily required to publish either a NOPD, if it finds that standards for the equipment do not need to be amended, or a NOPR including new proposed energy conservation standards not later than 6 years after the issuance of any final rule establishing or amending a standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(1)) Not later than two years after a NOPR is issued, DOE must publish a final rule amending the energy conservation standard for the equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)(3)(A)) The final rule that amended the current standards for CRE was issued in 2014. DOE is conducting this rulemaking pursuant to these statutory requirements. Additionally, pursuant to a consent decree entered on September 20, 2022 and amended on September 25, 2024, DOE has agreed to sign and post on DOE's publicly accessible website a rulemaking document for CRE by December 30, 2024, that, when effective, would be DOE's final agency action for

standards for CRE.<sup>27</sup> Regarding delaying compliance due to the transition to low-GWP refrigerants, see sections III.A.2.a and IV.J.3.f of this document.

In response to the August 2024 NODA, GAAS, NAMA, and Zero Zone commented that DOE did not allow sufficient time to review the documents, with an updated support document version published 10 days before the end of the comment period. (GAAS, No. 96 at p. 2; NAMA, No. 112 at p. 3; Zero Zone, No. 114 at p. 1) Zero Zone also commented that DOE should have made a comparison of changes between the October 2023 NOPR TSD and NODA support document. (Zero Zone, No. 114 at p.1)

In response to these comments, DOE notes that updates to the NODA support document were minor clarifications, and all changes were detailed under “Revision History” in Section 8. With regards to Zero Zone's request for a list of changes, DOE detailed any changes from the October 2023 NOPR throughout the August 2024 NODA.

#### B. Scope of Coverage

This final rule covers the commercial refrigeration equipment that meet the definition of “commercial refrigerators, freezers, and refrigerator-freezers,” as codified at 10 CFR 431.62.

“Commercial refrigerators, freezers, and refrigerator-freezers” means refrigeration equipment that: (1) is not consumer equipment (as defined in section 430.2 of part 430); (2) is not designed and marketed exclusively for medical, scientific, or research purposes; (3) operates at a chilled, frozen, combination chilled and frozen, or variable temperature; (4) displays or stores merchandise and other perishable materials horizontally, semi-vertically, or vertically; (5) has transparent or solid doors, sliding or hinged doors, a combination of hinged, sliding, transparent, or solid doors, or no doors; (6) is designed for pull-down temperature applications or holding temperature applications; and (7) is connected to a self-contained condensing unit or to a remote condensing unit. 10 CFR 431.62.

In the October 2023 NOPR, DOE proposed establishing equipment classes for high-temperature refrigerators and chef bases or griddle stands. 88 FR 70196, 70214–70215. DOE

<sup>27</sup> Consent Decree, *Nat. Res. Def. Council, Inc. v. Granholm*, No. 1:20-cv-09127 (S.D.N.Y.), Sept. 20, 2022), Amend. Consent Decree, *State of N.Y. v. Granholm*, No. 1:20-cv-09362 (S.D.N.Y. Sept. 25, 2024). See [www.nrdc.org/sites/default/files/ee-standards-settlement-20220920.pdf](http://www.nrdc.org/sites/default/files/ee-standards-settlement-20220920.pdf). September 25, 2024 amendment available at [ecf.nysd.uscourts.gov/doc1/127136202802](http://ecf.nysd.uscourts.gov/doc1/127136202802).

received several comments in response to the October 2023 NOPR regarding this proposal.

In response to the October 2023 NOPR, NYSERDA and NEEA and NWPCC supported DOE's addition of chef bases and high-temperature refrigerators to the scope of coverage for the CRE energy conservation standards, agreeing with DOE's assertion that there are technically feasible opportunities for significant cost-effective energy savings from these categories. (NYSERDA, No. 88 at p. 1; NEEA and NWPCC, No. 89 at pp. 4–5)

In response to the October 2023 NOPR, Continental disagreed with DOE's proposal to include standards for refrigerated chef bases and griddle stands at this time. (Continental, No. 86 at p. 2) Continental commented that while it concurred with this decision in the September 2023 Test Procedure Final Rule to prescribe new test conditions for refrigerated chef bases and griddle stands, actual testing has not been conducted to form a basis for establishing standards efficiency levels at the mandated conditions. (*Id.* at pp. 2–3)

In response to the comment from Continental comment about lack of test data, as discussed in section IV.C.1.c of this document, DOE has tested chef bases or griddle stands per the amended test procedure prescribed by the September 2023 Test Procedure Final Rule. In addition, manufacturers have had additional time to test chef bases and submit data since the publication of the October 2023 NOPR, and the August 2024 NODA provided additional opportunity to comment on the chef base or griddle stand analysis. For example, the CA IOUs commented on the August 2024 NODA stating that they conducted testing on CRE units, including chef bases or griddle stands. (The CA IOUs, No. 113, at p. 2). The CA IOUs tested 15 vertical solid door units (9 VCS.SC.M, 6 VCS.SC.L) and 5 chef bases or griddle stands (3 CB.SC.M, 2 CB.SC.L) to evaluate daily energy consumption and performance. *Id.* The CA IOUs commented that with DOE's test data published in the August 2024 NODA, the CA IOUs can confirm that the daily energy consumption values for the units they tested are consistent with DOE's data, and that the CA IOUs plan to share anonymized test results with the public once the CA IOUs finalize their test report. *Id.*

Therefore, DOE continues to include high-temperature refrigerators and chef bases and griddle stands within the scope of this final rule.

However, the scope of this final rule does not include some types of

commercial refrigerators, refrigerator-freezers, and freezers that meet the definition at 10 CFR 431.62. These include blast chillers, blast freezers, buffet tables or preparation tables, mobile refrigerated cabinets, refrigerated bottled- or canned-beverage vending machines, and, as discussed in section II.B.3 of this document, the large-capacity CRE ranges presented in table IV.6 for the VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L equipment classes.

See section IV.A.1 of this document for discussion of the equipment classes analyzed in this final rule.

### C. Test Procedure

EPCA sets forth generally applicable criteria and procedures for DOE's adoption and amendment of test procedures. (42 U.S.C. 6314(a)) Manufacturers of covered equipment must use these test procedures as the basis for certifying to DOE that their product complies with the applicable energy conservation standards and as the basis for any representations regarding the energy use or energy efficiency of the equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(s); and 42 U.S.C. 6314(d)). Similarly, DOE must use these test procedures to evaluate whether a basic model complies with the applicable energy conservation standard(s). 10 CFR 429.110(e). The current test procedure for CRE is codified at appendix B and includes provisions for determining daily energy consumption, the metric on which current standards are based. 10 CFR 431.66(e) This test procedure was amended in the September 2023 Test Procedure Final Rule, in which DOE amended and established test procedures for CRE as follows:

- (1) Established new definitions for high-temperature refrigerator, medium-temperature refrigerator, low-temperature freezer, and mobile refrigerated cabinet, and amended the definition for ice-cream freezer;
- (2) Incorporated by reference the most current versions of industry standards AHRI 1200, ASHRAE 72, and AHRI 1320;
- (3) Established definitions and a new appendix C including test procedures for buffet tables and preparation tables;
- (4) Established definitions and a new appendix D including test procedures for blast chillers and blast freezers;
- (5) Amended the definition and certain test conditions for chef bases or griddle stands;
- (6) Specified refrigerant conditions for CRE that use R-744;
- (7) Allowed for certification of compartment volumes based on computer-aided design ("CAD") models;
- (8) Incorporated provisions for defrosts and customer order storage cabinets specified in waivers and interim waivers;

(9) Adopted product-specific enforcement provisions;

(10) Clarified use of the lowest application product temperature ("LAPT") provisions;

(11) Removed the obsolete test procedure in appendix A; and

(12) Specified a sampling plan for volume and total display area ("TDA").

88 FR 66152, 66154.

In response to the October 2023 NOPR, Ravnitzky commented that the proposed rule lacks clear and detailed guidance on the test conditions and procedures for measuring energy consumption in CRE that use alternative refrigerants, such as hydrocarbons or CO<sub>2</sub>. (Ravnitzky, No. 57 at pp. 1–2) Ravnitzky added that these alternative refrigerants have different performance characteristics than conventional HFC refrigerants and may require different test methods to ensure accurate and consistent results. (*Id.* at p. 2) Ravnitzky suggested that DOE specify or reference the test conditions and procedures for measuring the energy consumption of CRE that use alternative refrigerants, and that these should be consistent with ASHRAE or AHRI standards or best practices for testing CRE. (*Id.*)

In response to the comment from Ravnitzky, the DOE CRE test procedure for CRE currently subject to energy conservation standards at 10 CFR 431.66(e) is located at appendix B and is applicable to CRE using any type of refrigerant. DOE notes that, consistent with ASHRAE 72–2022 with Errata, testing for self-contained equipment with hydrocarbon refrigerants (*e.g.*, R-290), CO<sub>2</sub> refrigerant (*i.e.*, R-744), or A2L refrigerants does not require a different test method than for self-contained equipment using conventional refrigerants. In appendix B, DOE provides specific instructions for CRE connected to a direct-expansion remote-condensing unit with R-744, which requires different liquid refrigerant measurements than direct-expansion remote-condensing units specified in appendix A to ASHRAE 72–2022 with Errata. Therefore, the appendix B is applicable to CRE using any type of refrigerant and is consistent with industry standards.

NEEA and NWPCC expressed concern that the October 2023 NOPR misses savings opportunities for the remote condensing equipment classes. (NEEA and NWPCC, No. 89 at p. 4) Specifically, NEEA and NWPCC recommended that remote condenser energy be accounted for in the testing and rating of CRE so that these energy-saving features can be assessed in the



energy use analysis. (*Id.*).<sup>28</sup> NEEA and NWPCC explained that DOE's present analysis does not test the remote condenser; therefore, the energy-saving design options that impact the consumption of the remote condenser do not impact the tested rating. (*Id.*) NEEA and NWPCC commented that this approach fails to consider efficiency options such as ECMs, evaporator fans, variable-speed compressors ("VSCs"), or controls for remote condensing CRE—all of which create opportunities for significant energy savings. (*Id.*)

In response to the comment from NEEA and NWPCC, the definition of "commercial refrigerator, freezer, and refrigerator-freezer" was established in EPCA. See 42 U.S.C. 6311(9)(A). The definition requires that the refrigeration equipment is connected to a self-contained condensing unit or to a remote condensing unit. The self-contained condensing unit is defined as an integral part of the refrigerated equipment, whereas the remote condensing unit is defined as being remotely located from the refrigerated equipment. Based on these definitions, the remote condensing unit energy use is currently accounted for by the DOE test procedure through a calculation approach specified in section 5.1 of AHRI 1200–2023, which is incorporated by reference in the DOE test procedure at appendix B. In the September 2023 Test Procedure Final Rule, DOE stated it is aware of remote condensing CRE models for which specific dedicated condensing units are intended for use with specific refrigerated cases. 88 FR 66152, 66205. For CRE used with dedicated condensing units, the actual compressor used during normal operation is known (*i.e.*, the compressor in the dedicated condensing unit). *Id.* Accordingly, testing the whole system using the same approach as required for a self-contained CRE unit may produce energy use results that are more representative of how this equipment actually operates in the field. *Id.* DOE understands that remote CRE are most commonly installed with rack condensing systems, and that installations with dedicated condensing units represent a very small portion of the remote CRE market. *Id.* DOE is not aware of any remote CRE that are capable of installations only with a dedicated remote condensing unit (*i.e.*, DOE expects that all remote CRE may be installed with rack condensing systems).

*Id.* In the June 2022 NOPR, DOE requested comment on its tentative determination not to propose amended test procedures for dedicated remote condensing units. *Id.* DOE only received comments agreeing with the June 2022 NOPR approach and DOE determined not to adopt test provisions for dedicated remote condensing units at this time. *Id.*

In response to the October 2023 NOPR, Continental commented that designing commercial refrigerators and freezers with technology options to meet energy limits in 75 °F/55-percent relative humidity ("RH") ambient conditions has shown to cause performance issues when these technologies are employed in real-world commercial kitchen conditions. (Continental, No. 86 at p. 3)

In response to the August 2024 NODA, Continental disagreed with DOE establishing test procedures and efficiency standards for commercial refrigerators and freezers using ambient testing conditions of 75 °F/55 percent RH, stating that these conditions do not correspond with energy consumption during a representative average use period as required by EPCA. (Continental, No. 107 at p. 2)

In response to the October 2023 NOPR and August 2024 NODA, Delfield disagreed with the 86 °F test ambient criteria for chef bases/griddle stands because it conflicts with the recently established Energy Star requirement, creating additional burden for manufacturers by requiring different test rooms from other equipment that is tested at 75/55 percent, and because it creates confusion for end-users when comparing energy consumption between unit types. (Delfield, No. 71, p. 1; Delfield, No. 99 at p. 2) Delfield added that 75/55 percent has been the primary ambient condition for CRE for around 40 years so they do not see a reason that this should change. (*Id.*) Delfield requested that DOE review this change and align with Energy Star version 5 regulations for ambient conditions and energy usage. (*Id.* at pp. 2–3)

In response to the comments from Continental and Delfield, the test procedure for equipment included in the scope of this rulemaking is prescribed at 10 CFR 431.64 and appendix B, and was finalized in the September 2023 Test Procedure Final Rule. As part of the test procedure rulemaking process, DOE provided stakeholders opportunity to comment on potential test procedure amendments, including on test conditions such as ambient temperature and humidity for testing. The September 2023 Test Procedure Final Rule

provides discussion of its deliberations in finalizing test procedures, for example regarding test ambient conditions for chef bases in section III.C.4 of the September 2023 Test Procedure Final Rule. See 88 FR 66152, 66203 (Sept. 26, 2023). DOE notes that the September 2023 Test Procedure Final Rule is consistent with the proposed addendum B to ASHRAE 72–2022,<sup>29</sup> which proposes the same test conditions for chef bases or griddle stands as in the DOE test procedure. In response to the comment from Delfield regarding end users' comparisons of products, DOE noted in the September 2023 Test Procedure Final Rule that manufacturers may not offer CRE in a different CRE equipment class with similar designs to any chef base or griddle stand, in which case end-users are likely concerned primarily about comparing chef bases or griddle stands to each other at the same ambient conditions. 88 FR 66152, 66200.

Hoshizaki and AHRI disagreed that the DOE test procedure for refrigerated buffet and preparation tables was a valid test procedure. (Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 6) Hoshizaki encouraged DOE to work with industry to make ASTM F2143, which is currently under review for final changes and votes, a valid test procedure with changes DOE requests. (Hoshizaki, No. 76 at p. 2)

In response to Hoshizaki and AHRI, DOE notes that the DOE test procedure for refrigerated buffet and preparation tables, located at appendix C to subpart C of part 431, already references the latest version of ASTM F2143 as one of several references for the test procedure for refrigerated buffet and preparation tables. As noted in the September 2023 Test Procedure Final Rule, DOE evaluated ASTM F2143–16 and identified the need for additional provisions or alternate requirements. 88 FR 66152, 66175. DOE noted that NSF 7 is intended to ensure refrigerating performance and food safety, not energy use; while ASTM F2143–16 was developed to evaluate energy performance, and with the additional requirements established in the September 2023 Test Procedure Final Rule, DOE determined that referencing ASTM F2143–16 is appropriate and meets the EPCA requirements. *Id.* DOE will consider any updates to industry test standards that are currently incorporated by reference, as well as any potential new industry test

<sup>28</sup> Remote condenser energy use is addressed in the current test procedure with standardized EER values rather than direct measurement of remote condenser performance. See section 5.1 of AHRI 1200–2023.

<sup>29</sup> See [www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/72\\_2022\\_b\\_20240830.pdf](http://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/72_2022_b_20240830.pdf).

standards relevant to refrigerated buffet and preparation tables in future test procedure rulemakings.

See section IV.A.1.c for additional comments and responses on refrigerated buffet or preparation tables and blast chillers and freezers.

ITW and NAFEM also commented that DOE's current test procedure tests CRE in given ambient temperature, humidity, and door opening conditions that fall short of actual field conditions. (ITW, No. 82 at p. 6; NAFEM, No. 83 at pp. 10–11) ITW and NAFEM commented that the total door-open time that the ASHRAE 72 test calls for amounts to 0.6 percent of a commercial refrigerator's operating day, whereas based on its empirical application data, a reach-in refrigerator in a 24-hour quick-service restaurant kitchen is open nearly 25 percent of the time, and a freezer is open nearly 12 percent of the time. (ITW, No. 82 at p. 6; NAFEM, No. 83 at p. 10) NAFEM also commented that most CRE are certified to NSF 7 for food storage, which requires passing a test at 100 °F. (NAFEM, No. 83 at p. 10) ITW commented that quickly restoring safe operating temperatures inside the cabinet requires a sizable refrigeration system and, unfortunately, this workload requires more electricity than the proposed regulations would allow. (ITW, No. 82 at p. 6) NAFEM stated that CRE must be designed with enough capacity to meet both NSF and customers' requirements, meaning large enough refrigeration systems to operate in these environments. (NAFEM, No. 83 at p. 11) NAFEM commented that CRE may not be able to keep potentially hazardous food products at safe temperatures when conditions are unfavorable under the proposed standards. (*Id.*)

In response to ITW and NAFEM's comments on the DOE test procedure not aligning with field conditions, EPCA sets forth the criteria and procedures DOE must follow when prescribing or amending test procedures for covered equipment. 42 U.S.C. 6314. EPCA requires that any test procedures prescribed or amended under this section must be reasonably designed to produce test results which reflect energy efficiency, energy use, or estimated annual operating cost of a given type of covered equipment during a representative average use cycle, and requires that test procedures not be unduly burdensome to conduct. (42 U.S.C. 6314(a)(2)). With respect to CRE, EPCA requires DOE to use the test procedures determined by the Secretary to be generally accepted industry standards, or industry standards developed or recognized by the

American Society of Heating, Refrigerating, and Air-Conditioning Engineers ("ASHRAE") or American National Standards Institute ("ANSI"). (42 U.S.C. 6314(a)(6)(A)(i)) With regard to self-contained CRE to which statutory standards are applicable, the required initial test procedure is the ASHRAE 117 test procedure in effect on January 1, 2005. (42 U.S.C. 6314(a)(6)(A)(ii)) Additionally, EPCA requires that if ASHRAE 117 is amended, the Secretary shall, by rule, amend the test procedure for the product as necessary to ensure that the test procedure is consistent with the amended ASHRAE 117 test procedure, unless the Secretary makes a determination, by rule, and supported by clear and convincing evidence, that to do so would not meet the statutory requirements regarding representativeness and burden. (42 U.S.C. 6314(a)(6)(E)) Finally, EPCA states that if a test procedure other than the ASHRAE 117 test procedure is approved by ANSI, DOE must review the relative strengths and weaknesses of the new test procedure relative to the ASHRAE 117 test procedure and adopt one new test procedure for use in the standards program. (42 U.S.C. 6314(a)(6)(F)(i)) In the September 2023 Test Procedure Final Rule, DOE determined that the amended DOE test procedure, by reference to AHRI 1200–2023 and ASHRAE 72–2022 with Errata for conventional CRE, provides a measure of energy use of CRE during a representative average use cycle and is not unduly burdensome to conduct. 88 FR 66152, 66205. DOE notes that the test procedure instructions in section 2.3 of appendix B allow for the use of integrated average temperatures and ambient conditions used for NSF testing in place of the DOE-prescribed integrated average temperatures and ambient conditions provided they result in a more stringent test.

In response to NAFEM and ITW's comments on refrigeration system size, DOE notes that no specific information on the refrigeration size to meet food safety requirements was received, and that DOE's representative analysis accounts for a variety of equipment when analyzing design specifications, including refrigeration system size. DOE further discusses food safety in relation to design options in section IV.B.1.f.

#### D. Technological Feasibility

##### 1. General

As discussed, any new or amended energy conservation standard must be designed to achieve the maximum improvement in energy efficiency that DOE determines is technologically

feasible and economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(A))

To determine whether potential amended standards would be technologically feasible, DOE first develops a list of all known technologies and design options that could improve the efficiency of the products or equipment that are the subject of the rulemaking. DOE considers technologies incorporated in commercially available products or in working prototypes to be "technologically feasible." 10 CFR 431.4; 10 CFR 430, subpart C, appendix A, sections 6(b)(3)(i) and 7(b)(1). Section IV.A.3 of this document discusses the technology options identified by DOE for this analysis. For further details on the technology assessment conducted for this final rule, see chapter 3 of the final rule TSD.

After DOE has determined which, if any, technologies and design options are technologically feasible, it further evaluates each technology and design option in light of the following additional screening criteria: (1) practicability to manufacture, install, and service; (2) adverse impacts on product utility or availability; (3) adverse impacts on health or safety; and (4) unique-pathway proprietary technologies. 10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, sections 6(b)(3)(ii)–(v) and 7(b)(2)–(5). Those technology options that are "screened out" based on these criteria are not considered further. Those technology options that are not screened out are considered as potential design options for the basis for higher efficiency levels that DOE could consider for potential amended standards. Section IV.B of this document discusses the results of this screening analysis conducted for this final rule. For further details on the screening analysis conducted for this final rule, see chapter 4 of the final rule TSD.

##### 2. Maximum Technologically Feasible Levels

EPCA requires that for any proposed rule that prescribes an amended or new energy conservation standard, or prescribes no amendment or no new standard for a type (or class) of covered equipment, DOE must determine the maximum improvement in energy efficiency or maximum reduction in energy use that is technologically feasible for each type (or class) of covered equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(p)(1)) Accordingly, in the engineering analysis, DOE identifies the maximum efficiency level currently available on



the market. DOE also defines a “max-tech” efficiency level, representing the maximum theoretical efficiency that can be achieved through the application of all available technology options retained from the screening analysis.<sup>30</sup> In many cases, the max-tech efficiency level is not commercially available because it is not currently economically feasible.

The max-tech levels that DOE determined for this analysis are described in section IV.C.1.b of this document and in chapter 5 of the final rule TSD.

### *E. Energy Savings*

#### *1. Determination of Savings*

For each TSL, DOE projected energy savings from application of the TSL to CRE purchased during the 30-year period that begins in the year of compliance with the new and amended standards (2029–2058).<sup>31</sup> The savings are measured over the entire lifetime of CRE purchased during the 30-year analysis period. DOE quantified the energy savings attributable to each TSL as the difference in energy consumption between each standards case and the no-new-standards case. The no-new-standards case represents a projection of energy consumption that reflects how the market for a product would likely evolve in the absence of new and amended energy conservation standards.

DOE used its national impact analysis (“NIA”) spreadsheet models to estimate NES from amended or new standards for CRE. The NIA spreadsheet model (described in section IV.H of this document) calculates energy savings in terms of site energy, which is the energy directly consumed by products at the locations where they are used. For electricity, DOE reports NES in terms of primary energy savings, which is the savings in the energy that is used to generate and transmit the site electricity. For natural gas, the primary energy savings are considered to be equal to the site energy savings. DOE also calculates NES in terms of FFC energy savings. The FFC metric includes the energy consumed in extracting, processing, and transporting primary fuels (*i.e.*, coal, natural gas, petroleum fuels), and thus presents a more complete picture of the impacts of energy conservation standards.<sup>32</sup> DOE’s

approach is based on the calculation of an FFC multiplier for each of the energy types used by covered products or equipment. For more information on FFC energy savings, see section IV.H.2 of this document.

#### *2. Significance of Savings*

To adopt any new or amended standards for a covered equipment, DOE must determine that such action would result in significant energy savings. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(B))

The significance of energy savings offered by a new or amended energy conservation standard cannot be determined without knowledge of the specific circumstances surrounding a given rulemaking.<sup>33</sup> For example, some covered products and equipment have most of their energy consumption occur during periods of peak energy demand. The impacts of these products on the energy infrastructure can be more pronounced than the impacts of products with relatively constant demand. Accordingly, DOE evaluates the significance of energy savings on a case-by-case basis, taking into account the significance of cumulative FFC national energy savings, the cumulative FFC emissions reductions, and the need to confront the global climate crisis, among other factors.

As stated, the standard levels adopted in this final rule are projected to result in NES of 1.11 quad full-fuel-cycle (“FFC”), the equivalent of the primary annual energy use of 7.4 million homes. Based on the amount of FFC savings, the corresponding reduction in emissions, and the need to confront the global climate crisis, DOE has determined the energy savings from the standard levels adopted in this final rule are “significant” within the meaning of 42 U.S.C. 6295(o)(3)(B).

### *F. Economic Justification*

#### *1. Specific Criteria*

As noted previously, EPCA provides seven factors to be evaluated in determining whether a potential energy conservation standard is economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(I)–(VII)) The following sections discuss how DOE has addressed each of those seven factors in this rulemaking.

amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).

<sup>33</sup> The numeric threshold for determining the significance of energy savings established in a final rule published on February 14, 2020 (85 FR 8626, 8670) was subsequently eliminated in a final rule published on December 13, 2021 (86 FR 70892).

#### *a. Economic Impact on Manufacturers and Consumers*

In determining the impacts of potential new or amended standards on manufacturers, DOE conducts an MIA, as discussed in section IV.J of this document. First, DOE uses an annual cash flow approach to determine the quantitative impacts. This step includes both a short-term assessment—based on the cost and capital requirements during the period between when a regulation is issued and when entities must comply with the regulation—and a long-term assessment over a 30-year period. The industry-wide impacts analyzed include: (1) INPV, which values the industry on the basis of expected future cash flows; (2) cash flows by year; (3) changes in revenue and income; and (4) other measures of impact, as appropriate. Second, DOE analyzes and reports the impacts on different types of manufacturers, including impacts on small manufacturers. Third, DOE considers the impact of standards on domestic manufacturer employment and manufacturing capacity, as well as the potential for standards to result in plant closures and loss of capital investment. Finally, DOE takes into account cumulative impacts of various DOE regulations and other regulatory requirements on manufacturers.

For individual consumers, measures of economic impact include the changes in LCC and PBP associated with new or amended standards. These measures are discussed further in the following section. For consumers in the aggregate, DOE also calculates the national NPV of the consumer costs and benefits expected to result from particular standards. DOE also evaluates the impacts of potential standards on identifiable subgroups of consumers that may be affected disproportionately by a standard.

#### *b. Savings in Operating Costs Compared To Increase in Price (LCC and PBP)*

EPCA requires DOE to consider the savings in operating costs throughout the estimated average life of the covered equipment in the type (or class) compared to any increase in the price of, or in the initial charges for, or maintenance expenses of, the covered equipment that are likely to result from a standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(II)) DOE conducts this comparison in its LCC and PBP analyses.

The LCC is the sum of the purchase price of an equipment (including its installation) and the operating cost (including energy, maintenance, and repair expenditures) discounted over

<sup>30</sup> In applying these design options, DOE would only include those that are compatible with each other that when combined, would represent the theoretical maximum possible efficiency.

<sup>31</sup> DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

<sup>32</sup> The FFC metric is discussed in DOE’s statement of policy and notice of policy

the lifetime of the equipment. The LCC analysis requires a variety of inputs, such as equipment prices, equipment energy consumption, energy prices, maintenance and repair costs, equipment lifetime, and discount rates appropriate for consumers. To account for uncertainty and variability in specific inputs, such as equipment lifetime and discount rate, DOE uses a distribution of values, with probabilities attached to each value.

The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of a more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost due to a more-stringent standard by the change in annual operating cost for the year that standards are assumed to take effect.

For its LCC and PBP analyses, DOE assumes that consumers will purchase the covered equipment in the first year of compliance with new or amended standards. The LCC savings for the considered efficiency levels are calculated relative to the case that reflects projected market trends in the absence of new or amended standards. DOE's LCC and PBP analyses are discussed in further detail in section IV.F of this document.

#### c. Energy Savings

Although significant conservation of energy is a separate statutory requirement for adopting an energy conservation standard, EPCA requires DOE, in determining the economic justification of a standard, to consider the total projected energy savings that are expected to result directly from the standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(III)) As discussed in section IV.H of this document, DOE uses the NIA spreadsheet models to project NES.

#### d. Lessening of Utility or Performance of Products

In establishing equipment classes, and in evaluating design options and the impact of potential standard levels, DOE evaluates potential standards that would not lessen the utility or performance of the considered equipment. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(IV)) Based on data available to DOE, the standards adopted in this document would not reduce the utility or performance of the equipment under consideration in this rulemaking.

#### e. Impact of Any Lessening of Competition

EPCA directs DOE to consider the impact of any lessening of competition, as determined in writing by the Attorney General, that is likely to result from a standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(V)) It also directs the Attorney General to determine the impact, if any, of any lessening of competition likely to result from a standard and to transmit such determination to the Secretary within 60 days of the publication of a proposed rule, together with an analysis of the nature and extent of the impact. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(ii)) To assist the Department of Justice ("DOJ") in making such a determination, DOE transmitted copies of its proposed rule and the October 2023 NOPR TSD to the Attorney General for review, with a request that DOJ provide its determination on this issue. In its assessment letter responding to DOE, DOJ concluded that the proposed energy conservation standards for CRE are unlikely to have a significant adverse impact on competition. DOE is publishing the Attorney General's assessment at the end of this final rule.

#### f. Need for National Energy Conservation

DOE also considers the need for national energy and water conservation in determining whether a new or amended standard is economically justified. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(VI)) The energy savings from the adopted standards are likely to provide improvements to the security and reliability of the Nation's energy system. Reductions in the demand for electricity also may result in reduced costs for maintaining the reliability of the Nation's electricity system. DOE conducts a utility impact analysis to estimate how standards may affect the Nation's needed power generation capacity, as discussed in section IV.M of this document.

DOE maintains that environmental and public health benefits associated with the more efficient use of energy are important to take into account when considering the need for national energy conservation. The adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and GHGs associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions, as discussed in section IV.K of this document; the estimated emissions

impacts are reported in section V.B.6 of this document. DOE also estimates the economic value of emissions reductions resulting from the considered TSLs, as discussed in section IV.L of this document.

#### g. Other Factors

In determining whether an energy conservation standard is economically justified, DOE may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i)(VII)) To the extent DOE identifies any relevant information regarding economic justification that does not fit into the other categories described previously, DOE could consider such information under "other factors."

#### 2. Rebuttable Presumption

EPCA creates a rebuttable presumption that an energy conservation standard is economically justified if the additional cost to the equipment that meets the standard is less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable DOE test procedure. (42 U.S.C. 6316(a); 42 U.S.C. 6295(o)(2)(B)(iii)) DOE's LCC and PBP analyses generate values used to calculate the effect potential amended energy conservation standards would have on the PBP for consumers. These analyses include, but are not limited to, the 3-year PBP contemplated under the rebuttable-presumption test. In addition, DOE routinely conducts an economic analysis that considers the full range of impacts to consumers, manufacturers, the Nation, and the environment, as required under 42 U.S.C. 6316(e)(1) and 42 U.S.C. 6295(o)(2)(B)(i). The results of this analysis serve as the basis for DOE's evaluation of the economic justification for a potential standard level (thereby supporting or rebutting the results of any preliminary determination of economic justification). The rebuttable presumption payback calculation is discussed in section V.B.1.c of this document.

### IV. Methodology and Discussion of Related Comments

This section addresses the analyses DOE has performed for this rulemaking with regard to CRE. Separate subsections address each component of DOE's analyses.

DOE used several analytical tools to estimate the impact of the standards considered in this document. The first tool is a spreadsheet that calculates the LCC savings and PBP of potential amended or new energy conservation



standards. The NIA uses a second spreadsheet set that provides shipments projections and calculates NES and NPV of total consumer costs and savings expected to result from potential energy conservation standards. DOE uses the third spreadsheet tool, the Government Regulatory Impact Model ("GRIM"), to assess manufacturer impacts of potential standards. These three spreadsheet tools are available on the DOE website for this rulemaking: [www.energy.gov/eere/buildings/commercial-refrigeration-equipment](http://www.energy.gov/eere/buildings/commercial-refrigeration-equipment). Additionally, DOE used output from the latest version of the Energy Information Administration's ("EIA's") *Annual Energy Outlook* ("AEO") for the emissions and utility impact analyses.

#### A. Market and Technology Assessment

DOE develops information in the market and technology assessment that provides an overall picture of the market for the equipment concerned, including the purpose of the equipment, the industry structure, manufacturers, market characteristics, and technologies used in the equipment. This activity includes both quantitative and qualitative assessments, based primarily on publicly available information. The subjects addressed in the market and technology assessment for this rulemaking include: (1) a determination of the scope of the rulemaking and equipment classes, (2) manufacturers and industry structure, (3) existing efficiency programs, (4) market and industry trends, and (5) technologies or design options that could improve the energy efficiency of CRE. The key findings of DOE's market assessment are summarized in the following sections. See chapter 3 of the final rule TSD for further discussion of the market and technology assessment.

#### 1. Equipment Classes and Definitions

When evaluating and establishing or amending energy conservation standards, DOE establishes separate standards for a group of covered equipment (*i.e.*, establish a separate equipment class) based on the type of energy used, or if DOE determines that an equipment's capacity or other performance-related feature justifies a different standard. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(q)) In making a determination whether a performance-related feature justifies a different standard, DOE considers such factors as the utility of the feature to the consumer and other factors DOE determines are appropriate. (*Id.*)

DOE currently sets forth energy conservation standards and relevant definitions for CRE equipment classes at

10 CFR 431.66 and 10 CFR 431.62, respectively. The October 2023 NOPR proposed some new equipment classes. In this final rule, DOE is maintaining the equipment classes and definitions proposed in the October 2023 NOPR as well as adopting several new equipment class modifications and new definitions that were introduced in the August 2024 NODA. The current equipment classes and the new definitions and equipment class modifications being finalized in this document and considered in the analysis are outlined as follows.

#### a. Current Equipment Classes and Definitions

DOE currently separates CRE into 49 equipment classes, which are categorized according to the following physical and functional attributes and equipment efficiency:

- (1) operating temperature—refrigerator ( $\geq 32^\circ\text{F}$ ), freezer ( $< 32^\circ\text{F}$ ), or ice-cream freezer ( $\leq -5^\circ\text{F}$ );
- (2) presence of doors—open (without doors) or closed (with doors);
- (3) door type—solid or transparent;
- (4) condensing unit—remote or self-contained;
- (5) configuration—horizontal, vertical, semivertical, or service over counter; and
- (6) temperature pull-down capability.

Definitions supporting the current equipment classes are as follows:

*Closed solid* means equipment with doors, and in which more than 75 percent of the outer surface area of all doors on a unit are not transparent.

*Closed transparent* means equipment with doors, and in which 25 percent or more of the outer surface area of all doors on the unit are transparent.

*Commercial freezer* means a unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating below  $32^\circ\text{F}$  ( $\pm 2^\circ\text{F}$ ).

*Commercial refrigerator* means a unit of commercial refrigeration equipment in which all refrigerated compartments in the unit are capable of operating at or above  $32^\circ\text{F}$  ( $\pm 2^\circ\text{F}$ ).

*Commercial refrigerator, freezer, and refrigerator-freezer* means refrigeration equipment that:

- (1) is not a consumer product (as defined in section 430.2 of part 430);
- (2) is not designed and marketed exclusively for medical, scientific, or research purposes;
- (3) operates at a chilled, frozen, combination chilled and frozen, or variable temperature;
- (4) displays or stores merchandise and other perishable materials horizontally, semivertically, or vertically;
- (5) has transparent or solid doors, sliding or hinged doors, a combination of hinged, sliding, transparent, or solid doors, or no doors;

(6) is designed for pull-down temperature applications or holding temperature applications; and

(7) is connected to a self-contained condensing unit or to a remote condensing unit.

*Door* means a movable panel that separates the interior volume of a unit of commercial refrigeration equipment from the ambient environment and is designed to facilitate access to the refrigerated space for the purpose of loading and unloading product. This includes hinged doors, sliding doors, and drawers. This does not include night curtains.

*Holding temperature application* means a use of commercial refrigeration equipment other than a pull-down temperature application, except a blast chiller or freezer.

*Horizontal closed* means equipment with hinged or sliding doors and a door angle greater than or equal to  $45^\circ$ .

*Horizontal open* means equipment without doors and an air-curtain angle greater than or equal to  $80^\circ$  from the vertical.

*Ice-cream freezer* means:

(1) prior to the compliance date(s) of any amended energy conservation standard(s) issued after January 1, 2023 for ice-cream freezers, a commercial freezer that is capable of an operating temperature at or below  $-5.0^\circ\text{F}$  and that the manufacturer designs, markets, or intends specifically for the storing, displaying, or dispensing of ice cream or other frozen desserts; or

(2) upon the compliance date(s) of any amended energy conservation standard(s) issued after January 1, 2023 for ice-cream freezers, a commercial freezer that is capable of an operating temperature at or below  $-13.0^\circ\text{F}$  and that the manufacturer designs, markets, or intends specifically for the storing, displaying, or dispensing of ice cream or other frozen desserts.

*Low-temperature freezer* means a commercial freezer that is not an ice-cream freezer.

*Medium-temperature refrigerator* means a commercial refrigerator that is capable of an operating temperature at or below  $40.0^\circ\text{F}$ .

*Pull-down temperature application* means a commercial refrigerator with doors that, when fully loaded with 12-ounce beverage cans at  $90^\circ\text{F}$ , can cool those beverages to an average stable temperature of  $38^\circ\text{F}$  in 12 hours or less.

*Remote condensing unit* means a factory-made assembly of refrigerating components designed to compress and liquefy a specific refrigerant that is remotely located from the refrigerated equipment and consists of one or more refrigerant compressors, refrigerant

condensers, condenser fans and motors, and factory-supplied accessories.

*Self-contained condensing unit* means a factory-made assembly of refrigerating components designed to compress and liquefy a specific refrigerant that is an integral part of the refrigerated equipment and consists of one or more refrigerant compressors, refrigerant condensers, condenser fans and motors, and factory-supplied accessories.

*Semivertical open* means equipment without doors and an air-curtain angle greater than or equal to 10° and less than 80° from the vertical.

*Service over counter* means equipment that has sliding or hinged

doors in the back intended for use by sales personnel, with glass or other transparent material in the front for displaying merchandise, and that has a height not greater than 66 inches and is intended to serve as a counter for transactions between sales personnel and customers.

*Transparent* means greater than or equal to 45-percent light transmittance, as determined in accordance with the ASTM Standard E 1084–86 (Reapproved 2009) (incorporated by reference, see section 431.63), at normal incidence and in the intended direction of viewing.

*Vertical closed* means equipment with hinged or sliding doors and a door angle less than 45°.

*Vertical open* means equipment without doors and an air-curtain angle greater than or equal to 0° and less than 10° from the vertical.

10 CFR 431.62.

On March 28, 2014, DOE published the March 2014 Final Rule that established the current equipment classes and corresponding standards for CRE. 79 FR 17725. Table IV.1 shows the current CRE equipment classes and standards.

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**Table IV.1 Current CRE Equipment Classes**

Condensing Unit Configuration	Equipment Family	Operating Temperature (°F)	Equipment Class Designation	Maximum Daily Energy Consumption (kWh/day)*
Remote Condensing (RC)	Vertical Open (VOP)	≥ 32	VOP.RC.M	0.64 x TDA + 4.07
		< 32	VOP.RC.L	2.2 x TDA + 6.85
		≤ -5	VOP.RC.I	2.79 x TDA + 8.7
	Semivertical Open (SVO)	≥ 32	SVO.RC.M	0.66 x TDA + 3.18
		< 32	SVO.RC.L	2.2 x TDA + 6.85
		≤ -5	SVO.RC.I	2.79 x TDA + 8.7
	Horizontal Open (HZO)	≥ 32	HZO.RC.M	0.35 x TDA + 2.88
		< 32	HZO.RC.L	0.55 x TDA + 6.88
		≤ -5	HZO.RC.I	0.7 x TDA + 8.74
	Vertical Closed Transparent (VCT)	≥ 32	VCT.RC.M	0.15 x TDA + 1.95
		< 32	VCT.RC.L	0.49 x TDA + 2.61
		≤ -5	VCT.RC.I	0.58 x TDA + 3.05
	Horizontal Closed Transparent (HCT)	≥ 32	HCT.RC.M	0.16 x TDA + 0.13
		< 32	HCT.RC.L	0.34 x TDA + 0.26
		≤ -5	HCT.RC.I	0.4 x TDA + 0.31
	Vertical Closed Solid ("VCS")	≥ 32	VCS.RC.M	0.1 x V + 0.26
		< 32	VCS.RC.L	0.21 x V + 0.54
		≤ -5	VCS.RC.I	0.25 x V + 0.63
	Horizontal Closed Solid (HCS)	≥ 32	HCS.RC.M	0.1 x V + 0.26
		< 32	HCS.RC.L	0.21 x V + 0.54
		≤ -5	HCS.RC.I	0.25 x V + 0.63
Self-Contained (SC)	Vertical Open (VOP)	≥ 32	SOC.RC.M	0.44 x TDA + 0.11
		< 32	SOC.RC.L	0.93 x TDA + 0.22
		≤ -5	SOC.RC.I	1.09 x TDA + 0.26
	Semivertical Open (SVO)	≥ 32	VOP.SC.M	1.69 x TDA + 4.71
		< 32	VOP.SC.L	4.25 x TDA + 11.82
		≤ -5	VOP.SC.I	5.4 x TDA + 15.02
	Horizontal Open (HZO)	≥ 32	SVO.SC.M	1.7 x TDA + 4.59
		< 32	SVO.SC.L	4.26 x TDA + 11.51
		≤ -5	SVO.SC.I	5.41 x TDA + 14.63
	Horizontal Closed Transparent (HCT)	≥ 32	HZO.SC.M	0.72 x TDA + 5.55
		< 32	HZO.SC.L	1.9 x TDA + 7.08
		≤ -5	HZO.SC.I	2.42 x TDA + 9
	Vertical Closed Transparent (VCT)	≥ 32	VCT.SC.M	0.1 x V + 0.86
		< 32	VCT.SC.L	0.29 x V + 2.95
		≤ -5	VCT.SC.I	0.62 x TDA + 3.29
	Vertical Closed Solid (VCS)	≥ 32	VCS.SC.M	0.05 x V + 1.36
		< 32	VCS.SC.L	0.22 x V + 1.38
		≤ -5	VCS.SC.I	0.34 x V + 0.88
	Horizontal Closed Solid (HCS)	≥ 32	HCT.SC.M	0.06 x V + 0.37
		< 32	HCT.SC.L	0.08 x V + 1.23
		≤ -5	HCT.SC.I	0.56 x TDA + 0.43
	Service Over Counter (SOC)	≥ 32	HCS.SC.M	0.05 x V + 0.91
		< 32	HCS.SC.L	0.06 x V + 1.12
		≤ -5	HCS.SC.I	0.34 x V + 0.88
	Pull-Down (PD)	≥ 32	SOC.SC.M	0.52 x TDA + 1
		< 32	SOC.SC.L	1.1 x TDA + 2.1
		≤ -5	SOC.SC.I	1.53 x TDA + 0.36

\*The term "V" means the chilled or frozen compartment volume (ft<sup>3</sup>) as defined in the Association of Home Appliance Manufacturers ("AHAM") Standard HRF 1-2008. The term "TDA" means the total display area (ft<sup>2</sup>) of the case, as defined in AHRI Standard 1200 -2006.

## BILLING CODE 6450-01-C

## b. Modifications to Equipment Classes and Definitions

Since the publication of the March 2014 Final Rule, there have been several proposed modifications to the equipment classes and definitions for CRE.

## Chef Bases or Griddle Stands and High-Temperature Refrigerators

In the September 2023 Test Procedure Final Rule amending and establishing test procedures for CRE, DOE established and amended definitions and test procedures for high-temperature refrigerators, medium-temperature refrigerators, and chef bases or griddle stands. 88 FR 66152, 66154–66155. Specifically, DOE established definitions for “high-temperature refrigerators” and “medium-temperature refrigerators,” amended the definition for “chef bases or griddle stands,” and incorporated by reference AHRI Standard 1200–2023 (I–P), which provides an integrated average temperature (“IAT”) of 55 °F ± 2.0 °F for which high-temperature refrigerators may be tested. *Id.* DOE also established a definition for “low-temperature freezers” and amended the definition for “ice-cream freezers.” *Id.* The newly established and amended definitions in the September 2023 Test Procedure Final Rule for chef bases or griddle stand and high-temperature refrigerator are as follows:

*Chef base or griddle stand* means commercial refrigeration equipment that has a maximum height of 32 inches, including any legs or casters, and that is designed and marketed for the express purpose of having a griddle or other cooking appliance placed on top

of it that is capable of reaching temperatures hot enough to cook food.<sup>34</sup> *High-temperature refrigerator* means a commercial refrigerator that is not capable of an operating temperature at or below 40.0 °F.

In the June 2022 Preliminary TSD, DOE had initially determined that additional equipment classes may be appropriate to address certain CRE available on the market. Specifically, DOE initially determined to split several commercial refrigerator equipment classes and establish separate classes for high-temperature refrigerators. Also, DOE indicated that it was considering establishing standards for chef bases or griddle stands with operating temperatures of ≥ 32 °F or < 32 °F, because this equipment is currently excluded from energy conservation standards.<sup>35</sup> See chapter 3 of the June 2022 Preliminary TSD.

In the October 2023 NOPR, based on CRE models certified to DOE’s Compliance Certification Database (“CCD”) under the lowest application product temperature<sup>36</sup> (“LAPT”) designation for commercial refrigerators, DOE proposed that high-temperature refrigerators be categorized under the self-contained and remote condensing unit configurations and under the VCT,

<sup>34</sup> The definition for “chef base or griddle stand” was established in the April 2014 CRE Test Procedure Final Rule. 79 FR 222778, 22282 (April 24, 2014). However, DOE has not, prior to this rulemaking, established standards for chef bases or griddle stands.

<sup>35</sup> See 10 CFR 431.66(f).

<sup>36</sup> Lowest application product temperature means the integrated average temperature (or for buffet tables or preparation tables, the average pan temperature of all measurements taken during the test) at which a given basic model is capable of consistently operating that is closest to the integrated average temperature (or for buffet tables or preparation tables, the average pan temperature of all measurements taken during the test) specified for testing under the DOE test procedure. 10 CFR 431.62.

VCS, SOC, VOP, SVO, and HZO equipment families. 88 FR 70196, 70213. For these equipment families with high-temperature equipment, DOE proposed to subcategorize them as high-temperature refrigerators (operating temperature greater than 40.0 °F) and medium-temperature refrigerators (operating temperature greater than or equal to 32.0 °F and less than or equal to 40.0 °F). *Id.* DOE proposed to maintain a single class for both medium and high temperature refrigerators, commercial refrigerator (operating temperature greater than or equal to 32.0 °F), for the remaining equipment families (*i.e.*, any horizontal closed transparent (“HCT”), horizontal closed solid (“HCS”), chef base or griddle stand (“CB”), or pull-down (“PD”) equipment that operates above 40 °F, if commercialized, would be considered a “commercial refrigerator” and required to comply with the “medium-temperature refrigerator” standard when tested at the LAPT). *Id.* For the October 2023 NOPR, DOE directly analyzed high-temperature refrigerators in the self-contained condensing unit configuration for the VCT and VCS equipment families. *Id.*

In the October 2023 NOPR, DOE also tentatively determined that chef bases or griddle stands can be categorized under the remote condensing or self-contained condensing unit configurations and the ≥ 32 °F or < 32 °F operating temperatures (*i.e.*, commercial refrigerator or low-temperature freezer, respectively). *Id.*

Therefore, in the October 2023 NOPR, DOE considered potential equipment classes for high-temperature refrigerators and chef bases or griddle stands and proposed potential equipment class structure modifications as presented in table IV.2. *Id.* at 88 FR 70214.



**Table IV.2 October 2023 NOPR Proposed Equipment Classes and Equipment Class Modifications**

Condensing Unit Configuration	Equipment Family	Rating Temperature**	Operating Temperature (°F)	Equipment Class Designation
Self-Contained (SC)	Vertical Open (VOP)	HR (55 °F)	$x > 40$	VOP.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VOP.SC.M
		LF (0 °F)	$x < 32$	VOP.SC.L
		IF (-15 °F)	$x \leq -13$	VOP.SC.I
	Semivertical Open (SVO)	HR (55 °F)	$x > 40$	SVO.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	SVO.SC.M
		LF (0 °F)	$x < 32$	SVO.SC.L
		IF (-15 °F)	$x \leq -13$	SVO.SC.I
	Horizontal Open (HZO)	HR (55 °F)	$x > 40$	HZO.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	HZO.SC.M
		LF (0 °F)	$x < 32$	HZO.SC.L
		IF (-15 °F)	$x \leq -13$	HZO.SC.I
	Vertical Closed Transparent (VCT)	HR (55 °F)	$x > 40$	VCT.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VCT.SC.M
		LF (0 °F)	$x < 32$	VCT.SC.L
		IF (-15 °F)	$x \leq -13$	VCT.SC.I
	Vertical Closed Solid (VCS)	HR (55 °F)	$x > 40$	VCS.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VCS.SC.M
		LF (0 °F)	$x < 32$	VCS.SC.L
		IF (-15 °F)	$x \leq -13$	VCS.SC.I
	Horizontal Closed Transparent (HCT)	CR (38 °F)	$x \geq 32$	HCT.SC.M
		LF (0 °F)	$x < 32$	HCT.SC.L
		IF (-15 °F)	$x \leq -13$	HCT.SC.I
	Horizontal Closed Solid (HCS)	CR (38 °F)	$x \geq 32$	HCS.SC.M
		LF (0 °F)	$x < 32$	HCS.SC.L
		IF (-15 °F)	$x \leq -13$	HCS.SC.I
	Service Over Counter (SOC)	HR (55 °F)	$x > 40$	SOC.SC.H*
		MR (38 °F)	$40 \geq x \geq 32$	SOC.SC.M
		LF (0 °F)	$x < 32$	SOC.SC.L
		IF (-15 °F)	$x \leq -13$	SOC.SC.I
	Pull-Down (PD)	CR (38 °F)	$x \geq 32$	PD.SC.M
	Chef Base or Griddle Stand (CB)	CR (38 °F)	$x \geq 32$	CB.SC.M*
		LF (0 °F)	$x < 32$	CB.SC.L*
	Vertical Open (VOP)	HR (55 °F)	$x > 40$	VOP.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VOP.RC.M
		LF (0 °F)	$x < 32$	VOP.RC.L
		IF (-15 °F)	$x \leq -13$	VOP.RC.I
	Semivertical Open (SVO)	HR (55 °F)	$x > 40$	SVO.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	SVO.RC.M
		LF (0 °F)	$x < 32$	SVO.RC.L
		IF (-15 °F)	$x \leq -13$	SVO.RC.I
	Horizontal Open (HZO)	HR (55 °F)	$x > 40$	HZO.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	HZO.RC.M
		LF (0 °F)	$x < 32$	HZO.RC.L

Remote Condensing (RC)	Vertical Closed Transparent (VCT)	IF (-15 °F)	$x \leq -13$	HZO.RC.I
		HR (55 °F)	$x > 40$	VCT.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VCT.RC.M
		LF (0 °F)	$x < 32$	VCT.RC.L
	Horizontal Closed Transparent (HCT)	IF (-15 °F)	$x \leq -13$	VCT.RC.I
		CR (38 °F)	$x \geq 32$	HCT.RC.M
		LF (0 °F)	$x < 32$	HCT.RC.L
	Vertical Closed Solid (VCS)	IF (-15 °F)	$x \leq -13$	HCT.RC.I
		HR (55 °F)	$x > 40$	VCS.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	VCS.RC.M
		LF (0 °F)	$x < 32$	VCS.RC.L
	Horizontal Closed Solid (HCS)	IF (-15 °F)	$x \leq -13$	VCS.RC.I
		CR (38 °F)	$x \geq 32$	HCS.RC.M
		LF (0 °F)	$x < 32$	HCS.RC.L
	Service Over Counter (SOC)	IF (-15 °F)	$x \leq -13$	HCS.RC.I
		HR (55 °F)	$x > 40$	SOC.RC.H*
		MR (38 °F)	$40 \geq x \geq 32$	SOC.RC.M
		LF (0 °F)	$x < 32$	SOC.RC.L
		IF (-15 °F)	$x \leq -13$	SOC.RC.I

\* Proposed new equipment class.

\*\* HR – High-Temperature Refrigerator

LF – Low Temperature Freezer

MR – Medium-Temperature Refrigerator

IF – Ice-Cream Freezer

CR – Commercial Refrigerator

In response to the October 2023 NOPR, ASAP *et al.* commented that they supported DOE's proposed standards for chef bases or griddle stands, which for medium- and low-temperature chef bases or griddle stands (CB.SC.M, CB.SC.L) would reduce energy usage by over 50 percent versus a baseline unit and provide significant cost savings for purchasers. (ASAP *et al.*, No. 79 at p. 2) ASAP *et al.* supported DOE's proposed standards for high-temperature refrigerators, stating that by moving away from existing medium-temperature standards, the new procedure better accounts for expected differences in energy use between medium- and high-temperature units. (*Id.*)

In this final rule, DOE is finalizing definitions and new equipment classes as proposed in the October 2023 NOPR for high-temperature refrigerators, medium-temperature refrigerators, ice-cream freezers, low-temperature freezers, and chef bases or griddle stands. In this final rule, DOE is also finalizing the same equipment class modifications, as proposed in the October 2023 NOPR, outlined in table IV.2.

#### New and Amended Definitions Adopted in This Final Rule

To account for the unique features and different energy use characteristics of certain types of CRE, in the October 2023 NOPR, DOE proposed to allow certain equipment classes that contain CRE with unique design characteristics, such as forced-air evaporators, pass-through doors, roll-in doors, roll-through doors, and sliding doors, to use a higher amount of energy than the newly proposed standards for their counterpart equipment without these features, defined using a "multiplier" value unique for each characteristic such that maximum energy use for a model with the characteristic is equal to the multiplier multiplied by the unadjusted maximum energy use for the equipment class. As proposed in the October 2023 NOPR, this equipment has the specified performance-related features and different maximum energy use to represent separate additional equipment classes. The multiplier values were selected with consideration that maximum allowed energy use for these models would comply with EPCA's "anti-backsliding" provision. 88 FR 70196, 70213. Therefore, in the October 2023 NOPR, DOE proposed definitions, to distinguish models with

the unique design features, for the terms "cold-wall evaporator," "forced-air evaporator," "pass-through doors," "roll-in door," "roll-through doors," and "sliding door," at 10 CFR 431.62. 88 FR 70196. *Id.* at 88 FR 70212–70213. These definitions, as proposed in the October 2023 NOPR, are as follows:

*Cold-wall evaporator* means an evaporator that comprises a portion or all of the commercial refrigerator, freezer, and refrigerator freezer cabinet's interior surface that transfers heat through means other than fan-forced convection.

*Forced-air evaporator* means an evaporator that employs the use of fan-forced convection to transfer heat within the commercial refrigerator, freezer, and refrigerator-freezer cabinet.

*Pass-through doors* means doors located on both the front and rear of the commercial refrigerator, freezer, and refrigerator-freezer.

*Roll-in door* means a door that includes a door sweep to seal the bottom of the door and may include a ramp that allows wheeled racks of product to be rolled into the commercial refrigerator, freezer, and refrigerator-freezer.

*Roll-through doors* means doors located on both the front and rear of the commercial refrigerator, freezer, and



refrigerator-freezer, that includes a door sweep to seal the bottom of the door and may include a ramp that allows wheeled racks of product to be rolled into and through the commercial refrigerator, freezer, and refrigerator-freezer.

*Sliding door* means a door that opens when a portion of the door moves in a direction generally parallel to its surface.

Section IV.C.1.a of this document discusses energy use allowances for CRE with the unique features defined in this section.

In the October 2023 NOPR, DOE also reviewed the current definitions for CRE at 10 CFR 431.62 and proposed to revise the definition for “rating temperature” to update the reference to the required IAT or LAPT, as applicable, as follows:

*Rating temperature* means the integrated average temperature a unit must maintain during testing, as determined in accordance with section 2.1 or section 2.2 of appendix B to subpart C of part 431, as applicable.

In response to the October 2023 NOPR, SCC agreed with DOE’s definitions for “cold-wall evaporator,” “forced-air evaporator,” “pass-through door,” “roll-in door,” “roll-through door,” “sliding door,” and “rating temperature.” (SCC, No. 74 at p. 3)

In response to the October 2023 NOPR, DOE received comments suggesting additional design features that should be provided additional energy use allowance, and definitions to distinguish them. ITW and Delfield recommended that DOE add definitions and energy use allowances for cabinets with drawers. (ITW, No. 82 at pp. 2, 4; Delfield, No. 71 at p. 2)

Based on these comments and DOE’s review of energy use differences between door and drawer units—discussed in section IV.C.1.c of this document—DOE is establishing a definition for “drawer unit” in this final rule. Commenters did not provide specific suggestions regarding a definition for drawer, hence DOE reviewed the definition of “drawer unit” at 20 California Code of Regulations (“CCR”) § 1602, and DOE is establishing the following definition for “drawer unit” in this final rule:

*Drawer unit* means a commercial refrigerator, freezer, or refrigerator-freezer in which all the externally accessed compartments are drawers.

In response to the October 2023 NOPR, SCC and AHRI commented that rear-door definitions should be added for SVO and VOP models to allow more energy for rear door options. (SCC, No. 74 at p. 3; AHRI, No. 81 at p. 5)

DOE notes that commenters did not provide data or other information to

suggest that SVO or VOP equipment with rear doors use more energy than the representative unit. For this reason, DOE is not expanding the definitions to include SVO or VOP equipment classes.

In summary, in this final rule, DOE is maintaining the definitions proposed in the October 2023 NOPR for “cold-wall evaporator,” “forced-air evaporator,” “pass-through door,” “sliding door,” “rating temperature,” “roll-in door,” and “roll-through door.” In this final rule, DOE is also establishing the “drawer unit” definition. Energy conservation standards, in terms of kWh/day, established in this final rule for equipment of certain classes which have these performance-related features allow for a higher maximum energy consumption (*i.e.*, less stringent) than the standards of the corresponding classes without these performance-related features, consistent with EPCA’s requirements for establishing separate equipment classes. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(q)) More detail regarding these classes is provided in IV.C.1.c of this document.

#### Units Under 30 Cubic Feet

In response to the October 2023 NOPR, NAMA commented that DOE does not fully account for the existence of smaller self-contained, refrigerated single- and double-door beverage and food coolers. (NAMA, No. 85 at p. 5) NAMA hypothesizes that inaccuracies in the October 2023 NOPR analysis (*e.g.*, engineering, shipments, economic impact, and utility impact) are due to DOE’s focus on larger-capacity equipment than 24-cubic-foot (ft<sup>3</sup>) CRE models that are typical of the market for NAMA’s members. (*Id.*) NAMA stated that what may apply in cost and energy efficiency for a 60-ft<sup>3</sup> unit may not apply to a 24-ft<sup>3</sup> unit. (*Id.* at p. 6) NAMA stated that doors, insulation, fan motors, compressors, and evaporator coils would be different for 30-ft<sup>3</sup> models compared to 60-ft<sup>3</sup> models. (*Id.*) NAMA commented that, for DOE’s analysis, units under 30 ft<sup>3</sup> should be considered as different from those over 30 ft<sup>3</sup> in refrigerated volume. (*Id.*) Furthermore, NAMA commented that between the June 2022 Preliminary Analysis and October 2023 NOPR, DOE changed the categories of products to include a number of door types but did not acknowledge that the capacity also causes a significant difference in cost and efficiency. (*Id.*) Therefore, NAMA recommended that DOE split the VCT.SC.M units into two categories because the characteristics are considerably different for units under 30 cubic feet than for those over 30 ft<sup>3</sup>. (*Id.*) In response the August 2024 NODA,

NAMA commented that DOE did not address its request to split VCT.SC.M, VOP.SC.M, and HZO.SC.L units under 30 cubic feet into separate categories, and that the NODA analysis has not substantially changed the overall impact to reflect that these products do not use as much energy as the larger units because the characteristics are considerably different compared to larger units. (NAMA, No. 112 at pp. 4–5)

In response to the October 2023 NOPR, NAMA and NAFEM commented that some components that are available for large grocery store machines are not available for smaller units using R–290 refrigerant. (*Id.*; NAFEM, No. 83 at p. 16)

In response to similar comments regarding components for models using R–290 refrigerant made by NAMA during the November 2023 public meeting, True Manufacturing Company, Inc. (“True”) stated that, when it comes to self-contained CRE, the component availability to transition to R–290 is already there. (Public Meeting Transcript, No. 64 at p. 74) True added that even today, it is more expensive to buy a shaded pole motor than an ECM, and ECMs available today all comply with all the regulations needed for non-sparking. (*Id.* at p. 75)

In response to these comments, DOE notes that, based on currently available compressors for small self-contained units, R–290 and R–600a refrigerant compressors are the most widely available compressor types. DOE also notes that the smallest model currently available in DOE’s CCD<sup>37</sup> for VCT.SC.M uses R–600a. In addition, as described in section IV.A.3.a, DOE analyzed an average compressor efficiency to account for a wide range of use cases.

In response to the comment from True, DOE agrees with True that R–290 compatible components are currently available for self-contained CRE, including CRE that have a volume of less than 30 ft<sup>3</sup>. DOE conducted a review of the CRE market, based on directly analyzed units and publicly available information (*e.g.*, specification sheets), and found no evidence of a difference in availability of R–290 compatible components used in less-than- 30- ft<sup>3</sup> models compared to larger models. Therefore, without additional data, DOE disagrees that there is a need for smaller equipment classes to analyze a different design option pathway than larger R–290 units.

In response to NAMA’s comments regarding the applicability of the cost

<sup>37</sup> See [www.regulations.doe.gov/certification-data/#q=Product\\_Group\\_s%3A\\*](http://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A*).

and energy efficiency for a 60-ft<sup>3</sup> unit compared to a 24-ft<sup>3</sup> unit, DOE notes that the representative analyzed volume for the VCT.SC.M class in the October 2023 NOPR was 49 ft<sup>3</sup>, not 60 ft<sup>3</sup>, and the representative volume has two doors (see table 5A.2.6 in the October 2023 NOPR TSD) which is within the range of number of doors that NAMA commented is typical of the market for NAMA's members. DOE reviewed the list of CRE manufacturers it identified as NAMA members in chapter 3, section 3.2.3.1 of the final rule TSD and found that these manufacturers have VCT.SC.M models with rated volumes of up to 63.32 ft<sup>3</sup> and two doors. A majority of these manufacturers also have models with certified volumes close to the VCT.SC.M representative volume analyzed in this final rule (e.g., 43.75 ft<sup>3</sup>, 41.11 ft<sup>3</sup>, and 40.7 ft<sup>3</sup>).

DOE is maintaining the 49 ft<sup>3</sup> representative volume for the VCT.SC.M ( $V \leq 100$ ) class in this final rule. Using information available to DOE at the time of this final rule regarding components and dimensions that would be used in CRE models with approximately 24 ft<sup>3</sup>, DOE conducted an analysis using its engineering spreadsheet to estimate the energy use of a CRE model with 24 ft<sup>3</sup> and concluded that the analysis is representative of test results for such a model. DOE has determined that including a representative volume of 24 ft<sup>3</sup> for the VCT.SC.M class would not significantly affect results and conclusions for the VCT.SC.M ( $V \leq 100$ ) class regarding efficiency levels that would be cost-effective. Therefore, DOE has determined that DOE's analysis accounts for CRE across the full capacity range of the VCT.SC.M ( $V \leq 100$ ) class, not just at the representative capacity, and, in the August 2024 NODA and this final rule, DOE did not present an analysis for CRE models with a volume of less than 30 ft<sup>3</sup>.

#### c. Equipment Without Standards Proposed in the October 2023 NOPR

In the October 2023 NOPR, due to a lack of data and information regarding performance and related design options of refrigerated buffet tables and preparation tables and blast chillers and blast freezers, DOE did not conduct an analysis of potential energy conservation standards for these equipment categories. 88 FR 70196, 70215–70216. DOE requested comment on refrigerated buffet and preparation tables and blast chillers and blast freezer design options, design specifications, and energy consumption data tested per the DOE test procedures located in appendices C and D of 10 CFR 431.64. *Id.*

In response to the October 2023 NOPR, SCC, Hoshizaki, AHRI, and Continental commented that manufacturers have not had time to test their equipment and evaluate the test procedure and agreed with DOE's tentative determination to not include energy conservation standards for buffet and preparation tables in this rulemaking. (SCC, No. 74 at p. 3; Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 6; Continental, No. 86 at p. 2) Hoshizaki offered to make chef bases or griddle stands, preparation tables, or other model samples available to DOE to help create the most accurate rulemaking possible. (Hoshizaki, No. 76 at p. 7)

In contrast, in response to the October 2023 NOPR, NEEA and NWPCC recommended that DOE include blast chillers and blast freezers and buffet tables in the scope of CRE energy conservation standards, develop a test procedure for blast chillers/freezers, and conduct analysis on the energy-saving potential for blast chillers/freezers and buffet tables. (NEEA and NWPCC, No. 89 at pp. 2–3) NEEA and NWPCC commented that by developing a test procedure that is applicable for their design intent, DOE could solve the issues of: (1) inadequate performance data and information for blast chillers and freezers, and (2) inapplicability of the established CRE test procedure for the design intent of “rapid temperature pull-down” (versus other typical CRE categories, which are intended for “holding temperature application”). (*Id.*) NEEA and NWPCC added that test procedures are particularly important for these classes because they are key to allowing the missing data to be collected, and NEEA and NWPCC recommended that DOE gather information on test methodology from all interested parties. (*Id.*) Regarding buffet tables, NEEA and NWPCC commented that because an established test procedure exists, DOE should gather performance data and then conduct an energy-savings analysis and consider standards for these equipment classes. (*Id.*)

Consistent with the October 2023 NOPR and comments received in response to that proposal, DOE has determined that it lacks sufficient data and information regarding blast chillers and blast freezer performance and related design options for units tested via the DOE test procedure. As stated in the September 2023 Test Procedure Final Rule, blast chillers and blast freezers are designed for “rapid temperature pull-down” capable of reducing the internal temperature from 135 °F to 40 °F within a period of 4

hours. 88 FR 66152, 66189. Therefore, DOE is not currently able to model expected performance of this equipment, because the established test procedure is significantly different from the test procedure applicable to other CRE categories, which are intended for “holding temperature application.” Due to a lack of data and information regarding performance of blast chillers and blast freezers, DOE has not conducted an analysis of potential energy conservation standards for these equipment categories in this final rule.

With regard to buffet tables and preparation tables, while DOE acknowledges that California Energy Commission's (“CEC's”) Modernized Appliance Efficiency Database System (“MAEDbS”) contains data for buffet and preparation tables, DOE notes that Title 20 of the CCR requires refrigerated buffet and preparation tables to follow the American National Standards Institute (“ANSI”)/American Society for Testing and Materials (“ASTM”) F2143–01 test method.<sup>38</sup> This test method has been revised several times, with ASTM F2143–16 being the most recent version. In the September 2023 Test Procedure Final Rule, DOE stated that ASTM F2143–16 cannot be referenced as a stand-alone test method, but it determined the approach based on ASTM F2143–16 with additional requirements is representative for buffet and preparation tables. 88 FR 66152, 66175. Therefore, in this final rule, DOE is not able to model expected performance of this equipment at this time because the established test procedure is significantly different from the test procedure applicable to other CRE categories and from the test procedure used to measure energy consumption for CEC's MAEDbS. Due to a lack of data and information regarding performance and related design options of refrigerated buffet and preparation tables, DOE has not conducted an analysis of potential energy conservation standards for these equipment categories in this final rule.

In this final rule, consistent with the October 2023 NOPR, DOE is not establishing energy conservation standards for buffet tables or preparation tables, blast chillers, or blast freezers.

However, any representations, including for certification of compliance, made with respect to the energy use or efficiency of buffet tables

<sup>38</sup> See table A–1 in 20 CCR § 1604.a.2 located at [govt.westlaw.com/calregs/Document/I132868504AC611EF8D0AD9C609AF9EC3?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=\(sc.Default\)](https://govt.westlaw.com/calregs/Document/I132868504AC611EF8D0AD9C609AF9EC3?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)).



or preparation tables, blast chillers, and blast freezers must be made in accordance with the results of testing pursuant to appendices C and D of 10 CFR 431.64.

DOE will continue to evaluate buffet tables or preparation tables, blast chillers, and blast freezers for potential future energy conservation standards rulemakings, and DOE continues to request data and information for this equipment.

#### d. Pull-Down Equipment

In response to the October 2023 NOPR, ASAP *et al.* encouraged DOE to consider amended standards for PD equipment that are consistent with the efficiency improvements required for other CRE equipment classes, stating that while no PD.SC.M models are certified in DOE's CCD, a unit could be certified as a PD unit in order to be subject to a less stringent standard—a concern stated by ASAP *et al.* in the past. (ASAP *et al.*, No. 79 at p. 4) ASAP *et al.* commented that current standards for a 49-ft<sup>3</sup> unit (the VCT.SC.M representative volume in the October 2023 NOPR analysis) permit about 8 percent more energy usage (6.20 kWh/day) for a PD.SC.M versus a VCT.SC.M unit of the same volume (5.76 kWh/day). (*Id.*) ASAP *et al.* commented that under DOE's proposal in the October 2023 NOPR, the 49-ft<sup>3</sup> PD.SC.M unit would be permitted to use nearly 80 percent more energy than a VCT.SC.M of the same volume (3.51 kWh/day). (*Id.*) ASAP *et al.* commented that manufacturers might design equipment that meets the “pull-down” definition to be subject to less stringent standards due to the September 2023 Test Procedure Final Rule establishing verification provisions for PD temperature applications. (*Id.*)

With respect to the comment from ASAP *et al.*, the “pull-down temperature application” is defined in 42 U.S.C. 6311(9)(d) and the equipment class was established by the Energy Policy Act of 2005 (Pub. L. 109–58).<sup>39</sup> In the September 2023 Test Procedure Final Rule, DOE established verification provisions for pull-down temperature applications based on the EPCA definition, which are intended to ensure

CRE are certified correctly as pull-down temperature applications. See 88 FR 66152, 66187–66189. DOE anticipates that it is unlikely that manufacturers would design equipment that meets the “pull-down temperature application” definition to be subject to less stringent standards because manufacturers do not appear to be doing so in response to the current DOE CRE standards. For example, there are no models currently certified to DOE's CCD in the PD.SC.M class,<sup>40</sup> and the PD.SC.M energy use standard is less stringent than the comparable VCT.SC.M- class energy use standard above 5 ft<sup>3</sup>. Consistent with the October 2023 NOPR, DOE did not directly analyze the pull-down, self-contained, medium temperature equipment class as a primary equipment class in this final rule. DOE has determined to maintain the current standard level for PD.SC.M because DOE did not receive any data or feedback regarding energy use characteristics and design options of PD equipment. DOE will continue to monitor the PD.SC.M equipment class and any models certified to this class, including assessment testing and verification of any model's ability to meet the pull-down temperature application definition.

#### 2. CRE Market

In the October 2023 NOPR, DOE requested comment on publicly available market data on CRE manufacturers or identification of any CRE manufacturers with large market shares not identified in chapter 3 of the October 2023 NOPR TSD. 88 FR 70196, 70218.

AHRI provided a list of known suppliers of CRE products for the United States that are not listed on the CCD site: Amteko Industries, Inc.; Atlantic Food Bars; Borgen Merchandising Systems; Buffalo Outfront; Carrier; Cayuga Displays; Custom Deli's Inc.; Duke Manufacturing Co.; Federal Industries; GTI Designs; MTL COOL, a Due North brand; NAFCOOL; Picadeli; Pure Cold; USR Brands; Unity® Commercial

Refrigeration; and Vortex Refrigeration. (AHRI, No. 81 at p. 6)

As part of DOE's market assessment for the October 2023 NOPR and this final rule, DOE compiled an equipment database of CRE models available in the United States. To develop a comprehensive equipment database of CRE basic models, DOE reviewed its CCD<sup>41</sup> supplemented by information from CEC's MAEDbS,<sup>42</sup> individual company websites, stakeholder comments (see AHRI, No. 81 at p. 6), and prior CRE rulemakings. To identify chef bases or griddle stands and high-temperature units, DOE reviewed publicly available data from web scraping of retail websites. DOE then reviewed its comprehensive equipment database to identify the original equipment manufacturers (“OEMs”) of the CRE models identified. DOE compared the list of suppliers provided by AHRI against its list of CRE manufacturers to ensure completeness. Based on this comparison, DOE amended its market assessment (see chapter 3 of the final rule TSD) to include two additional small, domestic OEMs, Atlantic Food Bars and Borgen Merchandising Systems, for this final rule. DOE determined that both OEMs would qualify as small, domestic businesses. Therefore, for this final rule, DOE updated its small business assessment and included these companies in its small business manufacturer subgroup analysis (*i.e.*, “regulatory flexibility analysis”) discussed in section VI.B of this document.

#### 3. Technology Options

In the October 2023 NOPR market analysis and technology assessment, DOE identified technology options initially determined to improve the efficiency of CRE, as measured by the DOE test procedure and shown in table IV.3.

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<sup>41</sup> U.S. Department of Energy's Compliance Certification Database is available at [www.regulations.doe.gov/certification-data/#q=Product\\_Group\\_s%3A%22Refrigeration%20Equipment%20Commercial\\_Single\\_Compartment.html#q=Product\\_Group\\_s%3A%22Refrigeration%20Equipment%20Commercial%2C%20Single%20Compartment%22](http://www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A%22Refrigeration%20Equipment%20Commercial_Single_Compartment.html#q=Product_Group_s%3A%22Refrigeration%20Equipment%20Commercial%2C%20Single%20Compartment%22) (last accessed Jan. 31, 2024).

<sup>42</sup> California Energy Commission's Modernized Appliance Efficiency Database is available at [cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx](http://cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx) (last accessed Jan. 31, 2024).

<sup>39</sup> See 119 STAT. 639 at [www.govinfo.gov/content/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf](http://www.govinfo.gov/content/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf).

<sup>40</sup> See [www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration\\_Equipment\\_-\\_Commercial\\_Single\\_Compartment.html#q=Product\\_Group\\_s%3A%22Refrigeration%20Equipment%20Commercial%2C%20Single%20Compartment%22](http://www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial_Single_Compartment.html#q=Product_Group_s%3A%22Refrigeration%20Equipment%20Commercial%2C%20Single%20Compartment%22).

**Table IV.3 Technology Options for CRE**

<b>Insulation</b>	<b>Evaporator</b>
Improved resistivity of insulation (insulation type)	Increased surface area
Increased insulation thickness	Improved evaporator coil design
Vacuum-insulated panels	Low-pressure differential evaporator
<b>Lighting</b>	<b>Condenser**</b>
Higher-efficiency lighting	Increased surface area**
Occupancy sensors	Tube-and-fin enhancements**
<b>Improved transparent doors*</b>	Microchannel condenser**
Low-emissivity coatings*	<b>Fans and fan motors</b>
Inert gas fill*	Evaporator fan motors
Vacuum-insulated glass*	Evaporator fan blades
Additional panes*	Evaporator fan controls
Anti-sweat heater controls*	Condenser fan motors**
Anti-fog films*	Condenser fan blades**
Frame design*	Condenser fan controls**
<b>Compressors**</b>	<b>Other technologies</b>
Improved compressor efficiency**	Defrost systems
Alternative refrigerants**	Expansion valve improvements
Variable-speed compressors**	Air-curtain design***
Linear compressors**	Night curtains***
	Liquid suction heat exchanger**

\* Only applies to equipment classes with doors

\*\* Only applies to self-contained equipment classes

\*\*\* Only applies to equipment classes without doors (open equipment classes)

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88 FR 70196, 70244.

DOE received several comments on the technology options presented in the October 2023 NOPR. DOE received general comments regarding the technology options along with comments specifically regarding single-speed compressors, expansion valves, and doors for open units. These are discussed in the following paragraphs.

In response to the October 2023 NOPR, and the August 2024 NODA, Hillphoenix commented that the many other additional regulatory changes underway have narrowed manufacturers' ability to explore new energy-efficient technologies. (Hillphoenix, No. 77 at p. 2; Hillphoenix, No. 110 at p. 2)

DOE appreciates Hillphoenix's candor in indicating that they have little quantitative information to provide regarding energy savings potential for some of the newer technology options. In this final rule, DOE has not analyzed technologies that fail the screening criteria, including "technologies that are not incorporated in commercial equipment or in commercially viable, existing prototypes will not be considered further". DOE has undertaken its analysis based on the best information available.

In response to the October 2023 NOPR, NAFEM commented that meeting that the October 2023 NOPR's proposed standards may force reductions in the capacity of certain CRE, which reduces its utility and may lead to increased energy consumption. (NAFEM, No. 83 at pp. 22–23) NAFEM stated that many of its members shared a concern that substantially bulking up insulation may be the only way to meet many of the standards outlined in the October 2023 NOPR, which eats into the capacity of CRE models and may force customers to add more energy-using equipment to store the same amount of product—equipment that impacts the environment. (*Id.* at p. 23) NAFEM commented that this is another reason why refurbished equipment might be the only choice for some customers. (*Id.*) NAFEM added that its members fear that customers may "tinker" with products to circumvent efficiency measures to achieve a better-performing product, with the end result being that DOE's targeted energy-efficiency gains will never materialize in practice, and that the proposed standards may even cause an increase in energy consumption. (*Id.*)

In response to this comment from NAFEM, DOE notes that the screening criteria in section IV.B of this document

screens out any technology options that are determined to have "a significant adverse impact on the utility of the equipment to subgroups of consumers, or result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time," including increased insulation thickness and other technologies that affect internal or external dimensions. Additionally, the baseline insulation thicknesses analyzed in this final rule were revised from the October 2023 NOPR, consistent with comments received in response to the October 2023 NOPR. See section IV.B.1.a of this document for more details on the screening analysis for the increased insulation thickness technology option and section IV.C.1.a.iii of this document for more details on the revised baseline insulation thicknesses. Additionally, see sections IV.F.7 and IV.G of this document for a detailed discussion on refurbished equipment.

#### a. High-Efficiency Single-Speed Compressors

In the October 2023 NOPR, DOE considered the design option of



improved compressor efficiency, which would have consisted of applying a compressor with improved energy efficiency in comparison to the baseline compressor analyzed. 88 FR 70196, 70228. In the October 2023 NOPR, DOE presented a baseline for self-contained equipment based on R-290 and expected the energy efficiency improvement associated with the change to R-290 to be due to the compressor. *Id.* DOE did not directly analyze an improved compressor efficiency design option beyond the R-290 baseline. *Id.*

In the August 2024 NODA, DOE updated its analysis of R-290 compressor performance to reflect the average compressor efficiency from the database of CRE compressors it has collected, instead of the maximum compressor efficiency as considered in the October 2023 NOPR. 89 FR 68788, 68792–68793. DOE was able to incorporate into the August 2024 NODA compressor data that was not available to DOE for the October 2023 NOPR. *Id.* In the August 2024 NODA, DOE presented updated baseline energy use associated with each equipment class, expressed as a reduction in energy compared to the currently applicable standard. *Id.* Additionally, in the August 2024 NODA, based on the AHRI January 2017 white paper, Tolerances and Uncertainties in Performance Data of Refrigerant Compressors, which is referenced by the AHRI 540 compressor performance rating standard (“AHRI 540”),<sup>43</sup> DOE revised its calculation of energy use for all compressors to be 5 percent higher than calculated using compressor performance coefficients, to account for the uncertainty associated with compressor energy performance prediction using coefficients that are determined based on a limited number of compressor tests. *Id.*

In response to the October 2023 NOPR, the CA IOUs and ASAP *et al.* recommended that DOE consider more efficient single-speed compressors as a design option in the engineering analysis. (CA IOUs, No. 84 at pp. 2–3; ASAP *et al.*, No. 79 at pp. 3–4) The CA IOUs commented that the single-speed compressor efficiency upgrades may be more cost-effective than variable-speed compressors. (CA IOUs, No. 84 at p. 3) The CA IOUs further commented that the energy efficiency ratio (“EER”) for R-290 single-speed compressors varies between 5.8 to 7.4 Btu/kWh in the capacity range of 5,000 to 6,000 Btu/h and between 6.0 to 7.5 Btu/kWh in the capacity range of 4,000 to 5,000 Btu/h.

(*Id.* at p. 2) The CA IOUs additionally stated that upgrading to the most energy-efficient single-speed compressors may add a minimal marginal cost to the unit’s price. (*Id.* at p. 3) ASAP *et al.* stated there appears to be a range of R-290 single-speed compressor efficiencies available for a given compressor type, capacity, input voltage, and power supply (*i.e.*, single vs. polyphase) and asked DOE to further consider improved single-speed compressor efficiency. (ASAP *et al.*, No. 79 at pp. 3–4)

In response to the August 2024 NODA, ASAP *et al.* commented that DOE’s analysis overstates energy use of compressors due to increasing energy use in the calculations by 5 percent, using the average efficiency of available R-290 compressors (even though manufacturers have the option to use the highest efficiency compressors), and the expectation that additional high-efficiency compressors will be introduced to the market in advance of the compliance date of amended standards. (ASAP *et al.*, No. 106 at p. 3)

The CA IOUs recommended that DOE reduce its Compressor Energy Use Adjustment from 5% to no more than 2.5%. (CA IOUs, No. 113, at p. 4) The CA IOUs commented that the AHRI white paper does not specify whether these curve-fitting methodologies tend to overestimate or underestimate compressor performance, so the uncertainty should not be assumed to be biased in either direction. (*Id.*)

In response to the CA IOUs and ASAP *et al.*, DOE notes that the R-290 compressor market is still evolving due to the October 2023 EPA Final Rule and other refrigerant related rulemakings associated with the AIM Act. Because of this, DOE cannot confidently assert that all manufacturers would be able to easily source the most efficient compressors available for all equipment classes. DOE notes that the most efficient compressor for a CRE unit varies based on many factors such as temperature application (*i.e.*, high, medium, low, or ice-cream temperature), unit capacity (*i.e.*, rated TDA or Volume), and physical differences in the units (*e.g.*, open versus closed, horizontal versus vertical, compressor space constraints). As a result, in this final rule, consistent with the August 2024 NODA, DOE has analyzed the average compressor efficiency based on the compressor data available at the time of this rulemaking. See section IV.C.1.a.ii for a discussion of the results of this baseline energy use analysis.

In response to the ASAP *et al.* and CA IOUs comments on the 5 percent

compressor adjustment that was applied for all compressors in the August 2024 NODA, DOE notes that the August 2024 NODA analysis was recalibrated to accommodate updates made since the October 2023 NOPR analysis, including the 5 percent compressor adjustment, such that the analyzed baseline energy use is representative of baseline equipment. As discussed by commenters in the October 2023 NOPR, and the AHRI January 2017 white paper, this 5 percent compressor adjustment is appropriate based on the uncertainty tolerances for compressor performance coefficients, and therefore DOE disagrees that the energy use of the compressors are overstated.

In response to the August 2024 NODA, Storemasters commented that equipment manufacturers have already made significant changes to equipment to comply with the 2017 standards and much of the current equipment incorporates new refrigerants, particularly self-contained models that utilize R-290. (Storemasters, No. 68 at p. 1)

As discussed later in section IV.C.1.a.ii, DOE does acknowledge that many CRE units have already transitioned to R-290 refrigerant. However, for most equipment classes, R-290 refrigerant is used in units that use less energy than the current standard allows. Therefore, DOE conducted an analysis to determine an appropriate baseline for equipment classes using R-290 refrigerant, which is discussed in detail in section IV.C.1.a.ii.

#### b. Expansion Valves

As discussed in chapter 5 of the October 2023 NOPR TSD, higher-efficiency expansion valves can control the flow of refrigerant to adapt to varying loads and ambient conditions, reducing the energy consumption in some CRE units. However, in the October 2023 NOPR analysis, DOE did not consider improved thermal expansion valves as a design option, because this technology is not likely to improve energy efficiency across all equipment classes.

In response to the October 2023 NOPR, the CA IOUs recommended that DOE consider thermal expansion valves (“TXVs”) as a technology option over capillary tubes for self-contained refrigeration equipment. (CA IOUs, No. 84 at p. 4) The CA IOUs commented that TXVs are more efficient than simple fixed orifice capillary tubes at regulating refrigerant flow under changing load conditions and save energy at the compressor, especially at very low load conditions (*e.g.*, an infrequently opened door). (*Id.*) The CA IOUs additionally

<sup>43</sup> For the AHRI white paper see [www.ahrinet.org/system/files/2023-06/compressors-white-paper.pdf](http://www.ahrinet.org/system/files/2023-06/compressors-white-paper.pdf).

stated that the DOE test procedure, based on ASHRAE 72, requires 16 hours with no door openings for refrigeration units and can capture the energy savings of TXVs in self-contained units. (*Id.*)

The CA IOUs also recommended that DOE include electronic expansion valves (“EEVs”) as a design option for remote condensing units, as EEVs are a reliable and cost-effective technology that provide a lower stable superheat than TXVs, allowing more of the evaporator surface to be utilized in latent energy exchange, reducing compressor run times, and resulting in a 10-to-20-percent reduction in energy use for these units. (*Id.* at pp. 3–4)

In response to the comment from the CA IOUs regarding expansion valves for self-contained equipment, DOE notes that many self-contained refrigeration systems likely already use TXVs. In addition, the range of conditions experienced by most self-contained refrigeration systems during the DOE test procedure are very limited (IAT must be maintained within  $\pm 2^\circ\text{F}$ ), and the refrigerant mass flow is determined more by the capacity of the compressors used in most models than the thermal load. Also, the pressure available to move refrigerant through the expansion device is mostly influenced by the ambient temperature, which does not vary significantly during the DOE test procedure. Finally, for closed cabinets the variation in evaporator exit superheat, outside of the time that the door is actually open, when the system can draw much warmer near-ambient-temperature air into the evaporator, is dampened by the thermal mass of product typically in a field-installed cabinet, which is simulated by the loads in the cabinet during the DOE test procedure. Hence, DOE expects that savings of TXVs as compared to optimized capillary tubes would be small, and DOE has not seen data showing that this impact would be significant.

In response to the comment from the CA IOUs regarding expansion valves for remote condensing equipment, although the CRE test procedure does give credit for an increase in measured evaporator temperature through the use of the AHRI 1200 EER table, similar to testing associated with self-contained equipment described above, the variations in expansion device inlet conditions and also of conditions affecting the evaporator exit refrigerant state are sufficiently limited that an EEV would save little energy.

#### c. Doors for Open Units

In response to the October 2023 NOPR, NEEA and NWPCC expressed

concern that DOE’s proposal misses savings opportunities for the open equipment classes. (NEEA and NWPCC, No. 89 at pp. 3–4) NEEA and NWPCC stated that DOE’s LCC analysis shows open equipment classes consume three to eight times the energy of comparable closed transparent/solid door-type units. (*Id.* at p. 4) NEEA and NWPCC commented that for some open-equipment families (e.g., VOP.RC.M and VOP.RC.L), DOE only considers occupancy sensors and night curtains and does not allow efficiency increases beyond these design options (*Id.*) NEEA and NWPCC commented also that it favors a standard for open-type equipment classes that has parity with closed-door counterparts rather than increasing the gap between the two equipment types. (*Id.*) NEEA and NWPCC stated that if DOE raised the standard, some manufacturers may add doors on their open units to decrease energy losses from the unit. (*Id.*)

DOE understands NEEA and NWPCC’s comment to mean that if DOE amended the standard, manufacturers may add doors on their open units to decrease energy losses from the unit; however, DOE notes that based on equipment classes already established in the CFR, the addition of doors would change the equipment class from being considered as an open case to being considered a closed case. As DOE has previously stated in the October 2023 NOPR, there are different physical and functional attributes for open and closed cases, thus parity in standards is likely not possible due to the increased air infiltration and radiation loads on open units. See 88 FR 70196, 70220. Therefore, in this final rule, DOE considered all the technology options that are generally known to be available in the engineering analysis for open cases.

#### B. Screening Analysis

DOE uses the following five screening criteria to determine which technology options are suitable for further consideration in an energy conservation standards rulemaking:

(1) *Technological feasibility. Technologies that are not incorporated in commercial equipment or in commercially viable, existing prototypes will not be considered further.*

(2) *Practicability to manufacture, install, and service. If it is determined that mass production of a technology in commercial equipment and reliable installation and servicing of the technology could not be achieved on the scale necessary to serve the relevant market at the time of the projected compliance date of the standard, then that technology will not be considered further.*

(3) *Impacts on product utility. If a technology is determined to have a significant adverse impact on the utility of the equipment to subgroups of consumers, or result in the unavailability of any covered equipment type with performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as equipment generally available in the United States at the time, it will not be considered further.*

(4) *Safety of technologies. If it is determined that a technology would have significant adverse impacts on health or safety, it will not be considered further.*

(5) *Unique-pathway proprietary technologies. If a technology has proprietary protection and represents a unique pathway to achieving a given efficiency level, it will not be considered further, due to the potential for monopolistic concerns.*

10 CFR 431.4; 10 CFR part 430, subpart C, appendix A, 6(c)(3) and 7(b).

In sum, if DOE determines that a technology, or a combination of technologies, fails to meet one or more of the listed five criteria, it will be excluded from further consideration in the engineering analysis. The reasons for eliminating any technology are discussed in the following sections.

The subsequent sections include comments from interested parties pertinent to the screening criteria, DOE’s evaluation of each technology option against the screening analysis criteria, and whether DOE determined that a technology option should be excluded (“screened out”) based on the screening criteria.

#### 1. Screened-Out Technologies

In the October 2023 NOPR, DOE tentatively determined to screen out increased insulation thickness and vacuum-insulated panels (“VIPs”) for “impacts on product utility” and linear compressors and air-curtain design for “practicability to manufacture, install, and service.” 88 FR 70196, 70222–70224. In the August 2024 NODA, DOE additionally presented a revised analysis with microchannel condensers screened out for “practicability to manufacture, install, and service” and evaporator fan controls screened out for “impacts on product utility.” 89 FR 68788, 68793.

DOE received several comments on the screening analysis in response to the October 2023 NOPR and August 2024 NODA, as discussed in the following sections.

#### a. Increased Insulation Thickness and Other Technologies That Affect Internal or External Dimensions

In the October 2023 NOPR analysis, and the August 2024 NODA, DOE screened out increased insulation thickness. See 88 FR 70196, 70222–



70223. Also, DOE did not consider increased-size evaporators or condensers in its analysis. 88 FR 70196, 70220.

In response to the October 2023 NOPR, Hussmann, Hoshizaki, AHRI, and SCC agreed with DOE's decision to screen out increased insulation thickness as a design option. (Hussmann, No. 80 at p. 4; Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 7; SCC, No. 74 at p. 3)

In response to the October 2023 NOPR, Hoshizaki commented that increased insulation will decrease volume due to set box sizes for restaurants and institutions, and it stated that due to customer demand, a smaller volume could result in lost sales for units that changed to lower capacity. (Hoshizaki, No. 76 at p. 2)

In response to the October 2023 NOPR, NAMA commented that several design options shown in the October 2023 NOPR TSD may have an impact on the overall machine capacity and that any design option that requires more space inside the machine must reflect the reduction of overall capacity. (NAMA, No. 85 at p. 15) NAMA commented also that larger condensers or evaporators, more insulation, and changes to type of glass resulting in new structural components all affect the overall capacity. (*Id.*) NAMA stated that the external dimensions of CRE are limited by the height of the building structure in break rooms or built-in areas, while the width and length are limited by the footprint of the machine and integration with other machines (*i.e.*, snack machines) to which CRE are paired. (*Id.*)

In response to the October 2023 NOPR, AHRI, SCC, and NAMA commented that DOE's NOPR analysis reflected consideration of increased insulation thickness for baseline models analyzed in its analysis. (AHRI, No. 81 at p. 7; SCC, No. 74 at p. 3; NAMA, No. 85 at pp. 28–29) Specifically, AHRI commented that for a number of equipment classes, the baseline insulation thicknesses used by DOE in its 2023 NOPR analysis are thicker than the thicknesses associated with the efficiency levels selected as energy conservation standards for those same classes in the 2014 final rule analysis. (*Id.*) NAMA stated that DOE did not discuss the resultant change in utility or performance in the October 2023 NOPR TSD, highlighting that the best example of this is the design option to add ½ inch of insulation to each of the product classes, which would result in smaller capacity, longer times for consumers to keep the doors open, and more frequent restocking. (*Id.*) NAMA

further commented that DOE consultants reported at the November 2023 Public Meeting that the baseline units had 1–1.5 inches of foam, but that the NOPR TSD indicates use of 2–2.5 inches insulation thickness used in the analysis. (NAMA, No. 85 at pp. 28–29)

DOE notes that, while the October 2023 NOPR analysis did screen out insulation thickness increase (see 88 FR 70196, 70222–70223), the comments from NAMA indicate that some clarification regarding insulation thicknesses used in the analysis is appropriate. Tables 5A.2.5–5A.2.8 in the October 2023 NOPR TSD show the baseline insulation thickness used in the analysis, which ranged from 2 inches to 2.5 inches depending on the equipment class. This was based on teardown data that DOE had at the time the October 2023 NOPR analysis was completed, and is thicker than the baseline insulation thickness of 1 inch to 1.5 inches used in the preliminary analysis. Additional teardown information collected after the October 2023 NOPR analysis was completed suggested the values used in the October 2023 NOPR analysis were too large for some equipment classes. Hence, for the NODA analysis, DOE updated the baseline insulation thicknesses to the following representative values: 1.5 inches for medium- and high-temperature equipment; 2.0 inches for low-temperature equipment; and 2.5 inches for ice-cream temperature equipment. These thicknesses were also used for the final rule analysis. See section IV.C.1.a.iii for more details.

Regarding the comment from NAMA that the baseline insulation thickness is 1 to 1.5 inches, NAMA may be referring to an exchange between True and DOE consultants at the November 2023 Public Meeting,<sup>44</sup> discussing the increased baseline insulation thickness increases stated by AHRI, SCC, and NAMA between the June 2022 Preliminary Analysis and the October 2023 NOPR. DOE's consultants responded in the November 2023 Public Meeting that the October 2023 NOPR baseline insulation thicknesses used in the NOPR analysis were representative of the baseline insulation thickness from teardown data available to DOE at the time of the October 2023 NOPR—as already noted above, these insulation thickness values were changed in the August 2024 NODA and final rule analyses based on additional teardown information and in consideration of stakeholder comments.

<sup>44</sup> See November 2023 Public Meeting Transcript, No. 64 at pp. 59–60.

As discussed in chapter 3 of the final rule TSD, increasing insulation thickness increases the thermal resistivity of the exterior of the unit, which in turn reduces the heat load that must be removed by the CRE's refrigeration system. Therefore, this technology option can reduce the energy use of CRE. However, consistent with comments from Hoshizaki and NAMA, because CRE is typically required to meet standard dimensions to fit into a fixed amount of space, the refrigerated volume of the unit may need to be decreased to accommodate increased insulation thickness, thus limiting the capacity of the unit. As a result, DOE has determined that, for certain configurations of CRE, increased insulation thickness meets the screening criterion of “impacts on product utility.” In this final rule, DOE has screened out increased insulation thickness as a design option for improving the energy efficiency of CRE.

DOE notes that, while increased insulation thickness has been screened out in this final rule, DOE may consider updating the representative baseline insulation thickness to reflect the current market in any future DOE actions or rulemakings.

In response to the comment from NAMA regarding consideration of larger condensers or evaporators as design options, DOE notes that these design options were not analyzed in the cost-efficiency results for the October 2023 NOPR or August 2024 NODA analysis, and is maintaining that approach in this final rule. Also, in response to the NAMA comment, design options associated with improvements to glass doors did not meet the screening criteria in the October 2023 NOPR or August 2024 NODA, and DOE maintains this approach for this final rule. DOE notes that some CRE currently available on the market incorporate the improved transparent door design options, which demonstrates the ability of CRE to use this technology. DOE discusses these design options in section IV.C.1 of this document and chapters 3 and 5 of the final rule TSD.

#### b. Vacuum-Insulated Panels

In the October 2023 NOPR, and the August 2024 NODA, DOE tentatively determined that vacuum-insulated panels meet the screening criterion of “impacts on product utility” and screened out vacuum-insulated panels as a design option for improving the energy efficiency of CRE. 88 FR 70196, 70223.

In response to the October 2023 NOPR, Hussmann, Hoshizaki, AHRI, and SCC agreed with DOE's decision to

screen out VIPs as a design option. (Hussmann, No. 80 at p. 4; Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 7; SCC, No. 74 at p. 3)

In response to the October 2023 NOPR, NAMA recommended that DOE remove VIPs from the rulemaking and from future rulemakings, due to the reasoning given in its response to the June 2022 Preliminary Analysis. (NAMA, No. 85 at p. 29)

In response to the October 2023 NOPR, Hoshizaki commented that VIPs are not a good alternative due to susceptibility of breakage and because the increased space needed to store VIPs for production preparation would necessitate much larger production facilities, resulting in larger capital expenditures. (Hoshizaki, No. 76 at p. 2)

As a confirmed by comments received in support of screening out VIPs, DOE is not aware of any implementations of VIPs—either in commercial equipment or in commercially viable, existing prototypes that could accommodate these structural requirements specific to CRE. As a result, DOE has determined that, at this time, vacuum-insulated panels implemented in CRE meet the screening criterion of “technological feasibility.” In this final rule, DOE has screened out vacuum-insulated panels as a design option for improving the energy efficiency of CRE.

In response to the comment from NAMA about future rulemakings, DOE notes that this screening analysis only applies to this final rule, and not to future actions or rulemakings. EPCA’s 6-year lookback provision allows DOE to consider technological advances and new technologies in future actions or rulemakings. Therefore, DOE may reconsider VIPs when conducting the screening analysis in any future action or rulemaking.

#### c. Linear Compressors

In the October 2023 NOPR, DOE tentatively determined that linear compressors meet the screening criterion of “practicability to manufacture, install, and service” and screened out linear compressors as a design option for improving the energy efficiency of CRE. 88 FR 70196, 70223.

In response to the October 2023 NOPR, Hussmann, Hoshizaki, AHRI, and SCC agreed with DOE’s decision to screen out linear compressors as a design option. (Hussmann, No. 80 at p. 4; Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 7; SCC, No. 74 at p. 3)

NAMA recommended that DOE remove linear compressors from the rulemaking and from future rulemakings, due to the reasoning given in its response to the June 2022

Preliminary Analysis. (NAMA, No. 85 at p. 29)

As a result of comments received in support of screening out linear compressors, DOE has determined that linear compressors meet the screening criterion of “practicability to manufacture, install, and service.” In this final rule, DOE has screened out linear compressors as a design option for improving the energy efficiency of CRE.

In response to the comment from NAMA about future rulemakings, DOE notes that this screening analysis only applies to this final rule, and not to future actions or rulemakings. EPCA’s 6-year lookback provision allows DOE to consider technological advances and new technologies in future actions or rulemakings. Therefore, DOE may reconsider linear compressors when conducting the screening analysis in any future action or rulemaking.

#### d. Air-Curtain Design

In the October 2023 NOPR, DOE tentatively determined that air-curtain design meets the screening criterion of “practicability to manufacture, install, and service” and screened out air-curtain design as a design option for improving the energy efficiency of CRE. 88 FR 70196, 70224.

In response to the October 2023 NOPR, Hussmann, Hoshizaki, AHRI, and SCC agreed with DOE’s decision to screen out air-curtain design as a design option. (Hussmann, No. 80 at p. 4; Hoshizaki, No. 76 at p. 2; AHRI, No. 81 at p. 7; SCC, No. 74 at p. 2)

As a result of comments received in support of screening out air-curtain design, DOE has determined that air-curtain design meet the screening criterion of “practicability to manufacture, install, and service.” In this final rule, DOE has screened out air-curtain design as a design option for improving the energy efficiency of CRE.

#### e. Permanent Magnet Synchronous AC Motors

In the October 2023 NOPR, DOE did not include permanent magnet synchronous motors (“PMS motors”) as a design option in its October 2023 NOPR engineering analysis. 88 FR 70196, 70221.

In response to the October 2023 NOPR, the CA IOUs recommended that DOE consider PMS motors as a design option for closed-door units. (CA IOUs, No. 84 at p. 6) The CA IOUs commented that PMS motors are 30 percent more efficient than electronically commutated motors and are considered the most efficient fan motor technology. (*Id.*) The CA IOUs commented also that while

some manufacturers report avoiding the use of PMS motors in their equipment due to noise concerns, noise should not be an issue for closed-door refrigeration units and there should be no significant barrier to adoption. (*Id.*) The CA IOUs stated that although DOE does not recommend PMS motors as a design option because specific commercialized PMS designs of the appropriate size and airflow were not identifiable, retrofit applications have used PMS motors in CRE connected to a remote condensing unit, vertical, transparent and open cases because of their appropriate size and airflow. (*Id.*)

With respect to the comment from the CA IOUs, DOE has observed that PMS motors are available for retrofit applications from one manufacturer,<sup>45</sup> but has not observed them in any new CRE. While PMS motors may be available for certain retrofit applications, DOE has not observed specific commercialized designs with the appropriate size and rated airflow for the range of equipment analyzed in support of this final rule. Based on these observations, along with discussions with manufacturers, DOE has determined that PMS motors meet the screening criterion of “practicability to manufacture, install, and service” to be excluded in the engineering analysis. Therefore, in this final rule, DOE has screened out PMS motors as a design option for improving the energy efficiency of CRE.

#### f. Evaporator Fan Control

In the October 2023 NOPR, DOE assumed that evaporator fans of baseline equipment runs continuously for 24 hours a day (except during electric defrost). DOE considered in its analysis a design option, “evaporator fan control,” in which evaporator fans cycle off for a portion of the compressor off cycles. DOE assumed for its analysis that evaporator fan control allows the fan to run during compressor off cycles 20-percent longer than the compressor on cycles, excluding the time period when the unit is in defrost mode. See chapter 5 of the October 2023 NOPR TSD. Based on testing of directly analyzed units, DOE observed that evaporator fan control is already implemented in certain models available on the market. DOE determined that 20-percent additional run time compared to the compressor on cycles is representative based on observation of its directly tested units that incorporate evaporator fan control. Based on manufacturer feedback on the June 2022 Preliminary Analysis, in the

<sup>45</sup> See [qmpower.com/products/](https://qmpower.com/products/).



October 2023 NOPR, DOE tentatively determined that evaporator fan control would only be suitable for closed, self-contained equipment—DOE limited the consideration of this design option in its October 2023 NOPR analysis to this equipment category.<sup>46</sup>

In response to the October 2023 NOPR, Hillphoenix, ITW, NAMA, NAFEM, and Ravnitzky commented with concern regarding the food safety implications of incorporating evaporator fan controls in the proposed standards. (Hillphoenix, No. 77 at p. 3; ITW, No. 82 at p. 6; NAMA, No. 85 at p. 16; NAFEM, No. 83 at pp. 10–11; Ravnitzky, No. 57 at p. 3)

In the November 2023 Public Meeting, Continental commented that it concluded that evaporator fan control resulted in freeze-ups on coils in the field, and it stopped using it for that reason. (November 2023 Public Meeting Transcript, No. 64 at pp. 68–69)

ITW commented that DOE should revise its October 2023 NOPR engineering spreadsheet assumptions to better reflect the current state of the industry in its application of fan control strategies. (ITW, No. 82 at p. 2) ITW stated that most manufacturers are already running fan duty cycles lower than 100 percent, so it is inaccurate to consider 100-percent fan duty cycle as the current industry baseline. (*Id.*) ITW also commented that to allow for proper off-cycle defrost and cabinet thermal performance, DOE should increase the duty cycle runtime multiplier to be a function of both compressor runtime and off-cycle defrost time, while allowing for additional run time for cabinet thermal destratification in the baseline calculation. (*Id.*)

ITW further commented that it disagrees with the fan control assumptions in the October 2023 NOPR engineering spreadsheet calculations, where the energy savings calculation for the “fan control strategy” is based on the difference between EFC1 (no fan control) and EFC2 (fan control), where the baseline EFC1 strategy assumes current products have 100-percent fan duty cycle and the improved EFC2 strategy assumes the fan duty cycle is equal to 120 percent of the compressor duty cycle. (*Id.* at p. 3) ITW stated that all ITW products have already adopted some form of fan control strategy to meet DOE’s 2017 energy standards and that, based on a recent NAFEM survey, 87.5 percent of the CRE manufacturers surveyed are already utilizing some form of fan control strategy. (*Id.*)

Furthermore, ITW commented that the proposed EFC2 strategy does not properly account for the need to run the evaporator fan during off-cycle defrost as well as outside of compressor and defrost cycles in order to provide adequate cooling and defrost performance and proper destratification of the cabinet air temperatures. (*Id.*) ITW elaborated that outside the compressor run period and off cycle defrost period is the only time zone that the fan control strategy can be played. (*Id.* at pp. 8–9) ITW stated that it conducted a study showing that 50 percent on, 50 percent off for an evaporator fan during a compressor off period is a good strategy to save energy while still maintaining a relatively uniform air and product temperature. (*Id.*) ITW stated that the evaporator fan run state during the compressor off period is irrelevant to compressor run time, and it will be the percentage of compressor off time. (*Id.*) ITW requested that for the EFC2 strategy, the fan duty cycle in the CRE engineering spreadsheet be calculated considering the formula:  $RT + O\text{CDT} + 50\% \times (24 - CRT - O\text{CDT})$ , where  $RT = \text{Compressor Runtime}$ ,  $O\text{CDT} = \text{Off-Cycle Defrost Time}$ . (*Id.* at pp. 3, 8) ITW provided an example for VCS.M case, claiming that DOE’s estimated evaporator fan run time is 7 hours less than the real application. (*Id.* at p. 9)

The CA IOUs recommended that DOE consider evaporator fan control as a design option for all closed, self-contained refrigeration equipment classes and not just for solid-door refrigeration units. (CA IOUs, No. 84 at pp. 4–5) The CA IOUs commented that variable-speed evaporator fan controls turn off the fans when the refrigeration door opens, reducing hot-air infiltration and the equipment’s energy use, and such controls also save fan energy when the compressor is off. (*Id.* at p. 4) The CA IOUs added that although evaporator frost buildup and temperature stratification may occur, fan “stir” cycles can mitigate these issues. (*Id.*)

In response to these comments, DOE reviewed the NSF 7 standard mentioned by commenters and found that section 6.10, “Performance—storage refrigerators and refrigerated food transport cabinets,” requires CRE to maintain an air temperature at or below 40 °F for all compartments; section 6.11, “Performance—storage freezers,” requires CRE to maintain an air temperature at or below 0 °F for all compartments; section 9.14, [Display Refrigerator] “Performance,” requires CRE to maintain an air temperature at or below 41 °F for display refrigerators

intended to hold potentially hazardous foods; section 9.15, [Display Refrigerator] “Performance—temperature recovery test,” requires CRE with automatic lockout to restore the air temperature in its food storage compartment to 41 °F or below after having its door open for 15 minutes; section 9.16, [Display Refrigerator] “Performance—automatic lockout,” requires CRE with automatic lockout to activate the door lock if the air temperature in the food storage compartment is greater than 41 °F for more than 30 minutes.

Evaporator fan control, as analyzed in the October 2023 NOPR, could reduce air distribution and temperature uniformity in the refrigerated compartment, potentially leading to temperatures outside of the NSF 7 tolerances. As mentioned in the comment from Continental, temperatures outside of the NSF 7 tolerances could also occur if the evaporator coil freezes up due to a lack of consistent airflow.

In response to the comment from ITW stating that most manufacturers currently incorporate evaporator fan control, DOE notes that it is unclear if the models referenced by ITW that meet DOE’s 2017 standards are units that have energy use at the current standard level, or at an energy use level more efficient than the current standards.

Further, DOE received feedback during manufacturer interviews that in CRE connected to remote condensing units, evaporator fans are always on, due to constant refrigerant flow through the system. Additionally, open CRE have evaporator fans on constantly to maintain the air curtain.

Although some self-contained, closed CRE may be able to use evaporator fan controls, there is insufficient information currently available to conclude that a significant number of CRE can use this approach and also comply with NSF 7 requirements. Therefore, in the August 2024 NODA, DOE removed evaporator fan controls as a design option. NAFEM, Continental, Hussmann, AHRI, Delfield, and Hillphoenix all commented in support of this decision. (NAFEM, No. 101 at pp. 2–3; Continental, No. 107 at p. 2; Hussmann, No. 108 at p. 2; AHRI, No. 104 at p. 8; Delfield, No. 99 at p. 2; Hillphoenix, No. 110 at p. 4)

The CA IOUs recommended that DOE reevaluate evaporator fan control as a design option for six CRE equipment classes: VCS.SC.H, VCS.SC.M, VCS.SC.L, VCS.SC.I, SOC.SC.M, and HCS.SC.M. (CA IOUs, No. 113 at p. 3) The CA IOUs commented that they subjected four commercially available

<sup>46</sup> See section 5.5.6 of the October 2023 NOPR TSD, located at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0051](https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0051).

units with evaporator fan controls from two manufacturers (3 VCS.SC.M, 1 VCS.SC.L) to a modified, more stringent NSF 7 test. *Id.* The CA IOUs added that they based the modified NSF 7 test on the formal NSF 7 test for display coolers, with modifications to unit loading and ambient dry bulb temperature. *Id.* The CA IOUs commented that, for cooler to pass the modified NSF 7 test, the average temperature of the warmest internal thermocouple must not exceed 41 °F, and no individual temperature readings shall exceed 43 °F. *Id.* For freezers, the integrated average temperature of all internal thermocouples must fall within  $0 \pm 2$  °F. *Id.* The CA IOUs commented that all four units met the internal temperature criteria despite these stringent test conditions. *Id.* The CA IOUs commented that, therefore, testing conducted by the CA IOUs on VCS.SC.M and VCS.SC.L CRE units indicates that units with evaporator fan controls can maintain internal compartment temperatures consistent with NSF 7. *Id.* The CA IOUs recommended that DOE gather more evidence related to these concerns to reevaluate the inclusion of evaporator fan controls in its engineering analysis, instead of simply removing a viable energy-saving technology from the analysis due to ‘uncertainty.’ *Id.*

ASAP et al. encouraged DOE to be less conservative in this rulemaking. (ASAP et al., No. 106 at p. 2) ASAP et al. stated that DOE screened out evaporator fan controls due to comments concerned about food safety, however DOE discussed in the October 2023 NOPR that the Department tested CRE units that incorporated evaporator fan controls, and the Department acknowledges in the NODA that NSF 7 food safety requirements do not preclude the use of evaporator fan controls, thus ASAP et al. encouraged DOE to include the technology. (*Id.*)

DOE recognizes that some self-contained, closed, CRE are able to use evaporator fan controls and comply with NSF 7 requirements, however, there is not sufficient information currently available to conclude that a significant number of CRE can use evaporator fan controls and comply with NSF 7.

Consistent with the results presented in the August 2024 NODA, DOE has determined that evaporator fan controls meet the screening criterion of “safety of technologies” for self-contained, closed CRE and “impacts on product utility” for CRE connected to remote condensing units and open CRE for this final rule. In this final rule, consistent with the results presented in the August 2024

NODA, DOE’s engineering analysis has the evaporator fan running constantly, except during electric defrost, in the baseline and all efficiency levels. This approach improves the ability of CRE to achieve better temperature uniformity, which can assist in ensuring food safe temperatures inside the unit.

#### g. Microchannel Condensers

In the October 2023 NOPR, DOE considered microchannel condensers as a design option for self-contained CRE, having observed the use of microchannel condensers in other commercial refrigeration equipment such as automatic commercial ice makers (“ACIMs”), including ACIMs that use R–290. 88 FR 70196, 70222.

In response to the October 2023 NOPR, SCC, NAFEM, and NAMA mentioned that microchannel condensers have clogging issues in the field. (SCC, No. 74 at p. 2; NAFEM, No. 83 at p. 7; NAMA, No. 85 at p. 12) Hoshizaki, NAMA, NAFEM, and Hussmann commented that microchannel condensers need more frequent cleaning than tube and fin heat exchangers. (Hoshizaki, No. 76 at p. 5; NAMA, No. 85 at p. 12; Hussmann, No. 80 at p. 12; NAFEM, No. 83 at pp. 6–7) SCC commented that clogging leads to increased energy consumption, while NAFEM and Hussmann stated that microchannels have little to no energy savings compared to tube and fin heat exchangers. (SCC, No. 74 at p. 2; NAFEM, No. 83 at p. 5; Hussmann, No. 80 at p. 5) AHRI added that microchannel condensers cannot always be substituted for fin and tube heat exchangers. (AHRI, No. 81 at p. 12) AHRI also stated the following microchannel condenser considerations: supplier tooling costs for custom configurations; existing and potential tariffs on components; significant lab testing to validate temperature and energy performance; field testing for reliability; product line changeovers; consideration for refrigerant charge; and air flow analysis to determine the impact on the air curtain. (*Id.*)

Hoshizaki commented that microchannel condensers have shorter lifetimes than current condensers, and NAMA added that when not maintained, microchannel condensers can cause premature failure of the compressor. (Hoshizaki, No. 76 at p. 5; NAMA, No. 85 at p. 12) NAMA and NAFEM commented that microchannel condensers can have leaks, which is not acceptable with flammable refrigerants, and are screened out in the household refrigeration rulemaking. (NAMA, No. 85 at pp. 12, 34; NAFEM, No. 83 at pp. 6–7) NAMA further stated that

microchannels show greater likelihood of pinhole leaks, and thus their use with flammable refrigerants could constitute a safety hazard. (NAMA, No. 85 at pp. 25, 34) NAMA added that microchannel condensers are not yet available in configurations for R–290 refrigerants, and NAMA has no information to suggest that they will be in the years ahead. (*Id.* at p. 25)

Hoshizaki commented that microchannel condensers would need time for engineering personnel to determine the best circuit for the refrigeration system and best way to join the piping. (Hoshizaki, No. 76 at p. 4) Hoshizaki stated that there will be a learning curve adding more time compared to that of current condensers to make sure the system is made in an optimal way and require value lost on increase of labor time for installation and testing. (*Id.* at pp. 4–5)

NAMA commented that it identified an inconsistency in DOE’s acceptance of microchannel condensers. (NAMA, No. 85 at pp. 12–13) NAMA and NAFEM pointed out that in the 2021 household refrigerator rulemaking, DOE decided not to pursue a rulemaking design option based on microchannel condensers.<sup>47</sup> (*Id.* at p. 13; NAFEM, No. 83 at pp. 6–7) NAMA requested clarification on whether microchannels are unacceptable or whether the TSD for household refrigeration is inaccurate. (NAMA, No. 85 at p. 13) NAMA recommended that DOE be consistent and screen out microchannels in CRE because the 2021 DOE household refrigeration appliances energy conservation standards rulemaking on household refrigeration appliances screened out microchannel condensers. (*Id.* at p. 34)

NAMA stated that microchannels require more frequent servicing and cleaning and added that DOE underestimated the extra time and cost. (*Id.* at p. 33) NAMA estimated the cost for fittings, machinery for insertion, other capital improvements, and additional servicing to be well over \$100. (*Id.*)

In response to the comments regarding microchannel condensers, DOE has observed microchannel condensers in other commercial refrigeration equipment such as ACIMs, including ACIMs that use R–290. However, DOE is not currently aware of microchannel condensers in use for CRE and did not observe microchannel condensers in any of the equipment in the teardown analysis. Even though

<sup>47</sup> See section 5.5.2 of the Residential Refrigerator NOPR TSD at [www.regulations.gov/document/EERE-2017-BT-STD-0003-0045](http://www.regulations.gov/document/EERE-2017-BT-STD-0003-0045).



DOE tentatively determined in the October 2023 NOPR that microchannel condensers would be technically feasible for use in CRE, feedback from commenters in response to the October 2023 NOPR suggests that there is current uncertainty as to the practicability to manufacture, install, or service this technology on the scale necessary to serve the CRE market at the time of the effective date of any new or amended standards. Recognizing this uncertainty, DOE tentatively screened out microchannel condensers as a design option in the August 2024 NODA. 89 FR 68788, 68793.

In response to the August 2024 NODA, ITW supported DOE's determination to screen-out microchannel condensers from consideration as a design option. (ITW, No. 111 at p. 1) Hillphoenix, NAFEM, Delfield, and Continental also commented in support of DOE's decision to screen-out microchannel condensers. (Hillphoenix, No. 110 at p. 4; NAFEM, No. 101 at pp. 2–3; ; Delfield, No. 99 at p.2; Continental, No. 107 at p. 2)

Based on the uncertainty associated with microchannel condensers, and consistent with the August 2024 NODA,

DOE screened-out microchannel condensers as a design option in this final rule. See chapter 4 of the final rule TSD for more information.

## 2. Remaining Technologies

Through a review of each technology, DOE concludes that all of the other technologies listed in table IV.4 met all five screening criteria to be examined further as design options in DOE's final rule analysis. In summary, DOE did not screen out the following technology options:

**Table IV.4 Remaining Technology Options for CRE**

<b>Insulation</b>	<b>Condenser**</b>
Improved resistivity of insulation (insulation type)	Increased surface area**
<b>Lighting</b>	<b>Tube-and-fin enhancements**</b>
Higher-efficiency lighting	<b>Fans and fan motors</b>
Occupancy Sensors	Evaporator fan motors
<b>Improved transparent doors*</b>	Evaporator fan blades
Low-emissivity coatings*	Condenser fan motors**
Inert gas fill*	Condenser fan blades**
Vacuum-insulated glass*	Condenser fan controls**
Additional panes*	<b>Compressor**</b>
Anti-sweat heater controls*	Improved compressor efficiency**
Anti-fog films*	Alternative refrigerants**
Frame design*	Variable-speed compressors**
<b>Evaporator</b>	<b>Other technologies</b>
Increased surface area	Defrost systems
Improved evaporator coil design	Expansion valve improvements
Low-pressure differential evaporator	Night curtains***
	Liquid suction heat exchanger**

\* Only applies to equipment classes with doors

\*\* Only applies to self-contained equipment classes

\*\*\* Only applies to equipment classes without doors (open equipment classes)

### a. Other Technologies Not Screened-Out

In response to the August 2024 NODA, ITW commented that they manufacture chef base and griddle stand models with both refrigerator (CB.SC.M) and freezer (CB.SC.L) storage compartment temperatures, and that these models have widths ranging from 36" to 139", and model volumes ranging from 4.5 cu-ft to 30.5 cu-ft. (ITW, No. 111 at p. 2) ITW commented that refrigerator models having widths greater than (CB.SC.M > 84") and freezer models having widths greater than (CB.SC.L > 60") use two or more evaporator coils spread along the width of the cabinet interior. (*Id.*) ITW commented that they currently do not understand the implications associated with the application of variable speed

reciprocating compressors in self-contained refrigeration systems with multiple evaporator circuits. (*Id.*) ITW urged DOE to provide additional information to stakeholders, and suggested that DOE screen-out EL3—"R-290 Variable Speed Reciprocating Compressor" from the list of available design options for both CB.SC.M and CB.SC.L CRE in their energy analysis. (*Id.*)

In response to the ITW comment, DOE notes that it had considered variable-speed compressors in its preliminary analysis (see pages 5–51 and 5–52 of the Preliminary Analysis TSD) and for its October 2023 NOPR analysis for chef bases (see pages 5–54 and 5–55 of the October 2023 NOPR TSD). Although DOE received many comments

regarding setting of standards for chef bases and regarding use of variable-speed compressors, DOE received no comments specifically about use of variable-speed compressors in this equipment class, nor use of variable-speed compressors in systems with multiple evaporator circuits. DOE also did not receive input regarding this topic in manufacturer interviews. DOE notes that variable-capacity compressor systems serving multiple evaporator circuits are quite common, *e.g.*, in supermarkets, where a single compressor rack can serve many individual evaporators in cabinets distributed throughout the store. DOE concludes that, while additional factors may need to be considered in the design and development for such systems,

there is no available information that would be the basis of screening the technology for the self-contained chef base equipment classes. Hence, DOE has considered variable speed compressors as a design option for these classes.

In response to the August 2024 NODA, NAFEM commented that DOE only removed some of the technologies NAFEM had suggested screening out in its comments in response to the October 2023 NOPR, and DOE did not provide a clear reason for why some technologies were removed and not others. (NAFEM, No. 101 at pp. 2–3)

NAFEM commented that it did not agree with DOE's decision to keep insulation, lighting, improved transparent doors, compressors, evaporators, condensers, fans, and other technologies including defrost systems, expansion valve, night curtains, and liquid suction heat exchangers in the analysis, as these are all already in-use technologies. (*Id.* at p.3) Additionally, NAFEM stated that occupancy-based lighting, microchannel condensers, and night curtains suffer from technical shortcomings, as NAFEM previously identified in their comments. (*Id.*)

DOE notes that in short, NAFEM commented that all identified technology options remaining after the screening analysis should be screened out. DOE notes that some of the technologies mentioned by NAFEM (*i.e.*, lighting, evaporators, and condensers) are analyzed in the baseline for all applicable equipment classes and are not analyzed as design options to improve efficiency (See appendix 5A of the October 2023 NOPR TSD for more details). In addition, some technologies were not directly analyzed in the October 2023 NOPR or August 2024 NODA, and continue to not be analyzed in this final rule (*i.e.*, defrost systems, expansion valves, and liquid suction heat exchangers) (See section 5.5.8 Design Options Not Directly Analyzed in the October 2023 NOPR TSD). While these technologies did not, and continue to not meet the screening criteria, DOE has not directly analyzed these design options as discussed further in chapter 5 of the final rule TSD. Finally, DOE did analyze design options in the October 2023 NOPR and August 2024 NODA for improved transparent doors, compressors, fans, occupancy sensors, and night curtains for applicable equipment classes, but notes that there are instances where DOE analyzed these technologies in the baseline, and did not consider those technologies as design options to improve efficiency (*i.e.*, baseline EC condenser or evaporator fan motor for certain equipment classes and R-290 baseline at the current standard

for certain equipment classes). For a full list of technology options analyzed at the baseline, see appendix 5A of the final rule TSD. DOE evaluated technology options to be implemented at and beyond baseline on an equipment class basis based on testing, component/equipment teardowns, manufacturer interviews, public comments, and review of online sources (*e.g.*, spec sheets), and therefore disagrees with NAFEM that all technologies should be screened out. See section IV.C.1 for further discussion on this topic.

DOE determined that these technology options are technologically feasible because they are being used or have previously been used in commercially available equipment or working prototypes. DOE also finds that all of the remaining technology options meet the other screening criteria (*i.e.*, practicable to manufacture, install, and service; do not result in adverse impacts on consumer utility, product availability, health, or safety; and do not utilize unique-pathway proprietary technologies). For additional details, see chapter 4 of the final rule TSD.

### C. Engineering Analysis

The purpose of the engineering analysis is to establish the relationship between the efficiency and cost of the equipment. There are two elements to consider in the engineering analysis: the selection of efficiency levels to analyze (*i.e.*, the “efficiency analysis”), and the determination of equipment cost at each efficiency level (*i.e.*, the “cost analysis”). In determining the performance of higher-efficiency equipment, DOE considers technologies and design option combinations not eliminated by the screening analysis. For each equipment class, DOE estimates the baseline cost, as well as the incremental cost for the equipment at efficiency levels above the baseline. The output of the engineering analysis is a set of cost-efficiency “curves” that are used in downstream analyses (*i.e.*, the LCC and PBP analyses and the NIA).

#### 1. Efficiency Analysis

DOE typically uses one of two approaches to develop energy efficiency levels for the engineering analysis: (1) relying on observed efficiency levels in the market (*i.e.*, the efficiency-level approach), or (2) determining the incremental efficiency improvements associated with incorporating specific design options to a baseline model (*i.e.*, the design-option approach). Using the efficiency-level approach, the efficiency levels established for the analysis are determined based on the market distribution of existing equipment (in

other words, based on the range of efficiencies and efficiency level “clusters” that already exist on the market). Using the design option approach, the efficiency levels established for the analysis are determined through detailed engineering calculations and/or computer simulations of the efficiency improvements from implementing specific design options that have been identified in the technology assessment. DOE may also rely on a combination of these two approaches. For example, the efficiency-level approach (based on actual equipment on the market) may be extended using the design option approach to interpolate to define “gap fill” levels (to bridge large gaps between other identified efficiency levels) and/or to extrapolate to the “max-tech” level (particularly in cases where the “max-tech” level exceeds the maximum efficiency level currently available on the market).

In the October 2023 NOPR, DOE relied on a design-option approach, supported with the testing and reverse engineering of directly analyzed CRE. 88 FR 70196, 70224. Consistent with the precedent set by March 2014 Final Rule analysis (see chapter 5 of the March 2014 Final Rule TSD),<sup>48</sup> DOE estimated the performance of design option combinations using an engineering analysis spreadsheet model. *Id.* at 88 FR 70225. This model estimates the daily energy consumption of CRE in kWh/day at various performance levels based on design details. *Id.* DOE generally relied on test data, CCD information, feedback from manufacturer interviews and public comments, publicly available component information, and reverse engineering to support and calibrate the engineering analysis spreadsheet model and the values of inputs to the models, such as compressor performance information, insulation thickness and thermal resistance, air infiltration, etc. *Id.* The model calculates energy consumption at each efficiency level separately for each analysis configuration. *Id.*

In the March 2014 Final Rule analysis, DOE selected 25 high shipment volume equipment classes, referred to as “primary” classes, selecting a representative capacity (defined by refrigerated volume or TDA, depending on the class), to analyze using the engineering analysis. DOE has used the term “directly analyze” to refer to use of the engineering spreadsheet to calculate energy use for the representative unit of a given primary

<sup>48</sup> See [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).



equipment class. Analyses or energy use levels of so-called “secondary” equipment classes were based on the analysis results determined for the primary equipment classes (see chapter 5 of the March 2014 Final Rule TSD).<sup>49</sup> In the October 2023 NOPR analysis, DOE followed a similar approach of directly analyzing 28 primary equipment classes. *Id.* DOE directly analyzed the same primary equipment classes as the March 2014 Final Rule, with the following changes: the PD.SC.M equipment class was not included, and DOE directly analyzed 4 new equipment classes, including VCT.SC.H, VCS.SC.H, chef base or griddle stand self-contained medium temperature (“CB.SC.M”), and chef base or griddle stand self-contained low temperature (“CB.SC.L”). *Id.*

In response to the October 2023 NOPR, ASAP *et al.* supported DOE’s approach for the engineering analysis, which was supported by testing, physical and catalog teardowns, and manufacturer feedback and estimated both the energy use and the manufacturer production cost (“MPC”) from use of additional design options in CRE that increase efficiency. (ASAP *et al.*, No. 79 at p. 2) ASAP *et al.* commented that DOE’s design option approach represents a robust method for estimating the incremental cost and expected efficiency improvements associated with specific design options for CRE and stated that this approach is consistent with DOE’s analysis for other rulemakings. (*Id.*)

In this final rule analysis, DOE has followed the same methodology as the October 2023 NOPR, except for the updates outlined in the following sections. In this final rule, consistent with the analysis in the August 2024 NODA, DOE analyzed a different representative capacity for the SOC.SC.M equipment class that assumes the use of R-290. DOE also made changes to the baseline analysis, including updating the R-value and thickness of insulation, updating the compressor performance assumptions, updating certain baseline components, and updating baseline design specifications for some equipment classes. Additionally in this final rule, DOE removed some design options (as discussed in section IV.B of this document) and updated the analysis approach or key performance characteristics of some design options (as discussed in section IV.C of this document).

Also consistent with the August 2024 NODA, DOE made updates to the multiplier approach, as discussed in section IV.C.1.c of this document.

#### a. Baseline Energy Use

For each equipment class, DOE generally selects a baseline model as a reference point for each class, and measures anticipated changes resulting from potential energy conservation standards against the baseline model. The baseline model in each product/equipment class represents the characteristics of a product/equipment typical of that class (e.g., capacity, physical size). Generally, a baseline model is one that just meets current energy conservation standards, or, if no standards are in place, the baseline is typically the most common or least efficient unit on the market.

#### i. Representative Unit Capacity

In performing the engineering analysis for CRE, DOE selected representative units for each primary equipment class to serve as analysis points in the development of cost-efficiency curves. In the October 2023 NOPR, DOE directly analyzed 28 primary equipment classes, at a single representative capacity for each CRE equipment class. 88 FR 70196, 70225.

Few of the NOPR comments explicitly addressed the DOE approach of conducting analysis at a single representative capacity for each class. Some comments regarding selection of the slope or intercept of the energy conservation standard line as a function of volume or TDA are related to the single-capacity approach—this is because determination of appropriate slope could potentially be evaluated on the basis of conducting analysis for two representative capacities. Such comments are discussed in section IV.C.1.d of this document. For some equipment classes, the topic of representative capacity is also affected by refrigerant transition—this is discussed in more detail in section IV.C.1.a.ii of this document. Finally, NAMA submitted a comment regarding VCT.SC.M models with refrigerated volume less than 30 cu.ft. (NAMA, No. 85 at pp. 5–6). This comment addresses both the potential for establishing a separate class for such models, as well as the representativeness of DOE’s selected representative capacity. Hence, this comment is addressed in section IV.A.1.b of this document and is not discussed here.

In response to the August 2024 NODA, ITW commented that after reviewing table 1.2 in the NODA support document, it would appear

DOE’s analysis focused on models with interior volumes <10 cu-ft for refrigerators and <12 cu-ft for freezers, and that the engineering spreadsheet used an example model of 9.5 cu-ft. (ITW, No. 111 at p. 2) ITW commented expressed concern for the proposed standards encompassing models with volumes greater than 12 cu-ft employing technology at an energy efficiency level of EL3. *Id.*

In response to this comment from ITW, DOE notes that it not only considered the test data presented in table 1.2 of the NODA support document, but also reviewed information publicly available online, as well as information gathered through manufacturer interviews and comments in response to the October 2023 NOPR and August 2024 NODA. While DOE acknowledges there are chef bases or griddle stands larger than the units DOE directly tested, based on the additional chef base or griddle stand data DOE received and reviewed for larger volumes, DOE determined that this data was consistent with the analysis for DOE’s representative unit volumes.

No other comments were submitted related to use of a single representative capacity for each class in the analysis.

#### ii. Addressing Refrigerant Transition

In the October 2023 NOPR analysis, DOE addressed the ongoing refrigerant transition mandated by the AIM Act and EPA regulations. 70196, 70226–70228. Specifically, DOE noted that, pursuant to the AIM Act, EPA proposed in the December 2022 EPA NOPR that all commercial refrigeration equipment would have to transition to refrigerants with GWP less than 150 or less than 300, depending on equipment characteristics (e.g., self-contained vs. operating with a remote condenser), by January 1, 2025. *Id.* After publication of the October 2023 NOPR, EPA published a final rule, “Phasedown of Hydrofluorocarbons: Restrictions on the Use of Certain Hydrofluorocarbons Under the American Innovation and Manufacturing Act of 2020” (“October 2023 EPA Final Rule”), which extended the compliance date for equipment operating with a remote condenser to January 1, 2026, for remote-condensing equipment used in supermarkets to January 1, 2027, for refrigerated food processing and dispensing equipment except for equipment within the scope of UL 621 to January 1, 2027, and for refrigerated food processing and dispensing equipment within the scope of UL 621 to January 1, 2028. 88 FR 73098, 73209 (October 24, 2023). See table IV.5 for a list of all GWP limits and compliance dates applicable to CRE that

<sup>49</sup> See [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).

were finalized in the October 2023 EPA Final Rule.

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**Table IV.5 October 2023 EPA Final Rule Summary for CRE October 2023 EPA Final Rule Summary for CRE**

Sectors and Subsectors	GWP Limit or Prohibited Substance(s)	Compliance Date
Retail food refrigeration – stand-alone units	150	January 1, 2025
Retail food refrigeration – refrigerated food processing and dispensing equipment – self-contained equipment with charge sizes ≤ 500 grams outside the scope of UL 621	150	January 1, 2027
Retail food refrigeration – refrigerated food processing and dispensing equipment – self-contained equipment with charge sizes > 500 grams outside the scope of UL 621 and remote condensing equipment	R-402A, R-402B, R-404A, R-407A, R-407B, R-407C, R-407F, R-407H, R-408A, R-410A, R-410B, R-411A, R-411B, R-417A, R-417C, R-420A, R-421A, R-421B, R-422A, R-422B, R-422C, R-422D, R-424A, R-426A, R-427A, R-428A, R-434A, R-437A, R-438A, R-507A, HFC-134a, HFC-227ea, R-125/290/134a/600a (55/1/42.5/1.5), RB-276, RS-24 (2002 formulation), RS-44 (2003 formulation), GHG-X5, or Freeze 12	January 1, 2027
Retail food refrigeration – refrigerated food processing and dispensing equipment – self-contained equipment within the scope of UL 621		January 1, 2028
Retail food refrigeration – supermarket systems with refrigerant charge capacities of 200 pounds or greater	150	January 1, 2027
Retail food refrigeration – supermarket systems with refrigeration charge capacities less than 200 pounds charge	300	January 1, 2027
Retail food refrigeration – supermarket systems, high temperature side of cascade system	300	January 1, 2027
Retail food refrigeration – remote condensing units with refrigerant charge capacities of 200 pounds or greater	150	January 1, 2026
Retail food refrigeration – remote condensing units with refrigerant charge capacities less than 200 pounds	300	January 1, 2026
Retail food refrigeration – remote condensing units, high temperature side of cascade systems	300	January 1, 2026



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As discussed in the October 2023 NOPR, DOE assumed that manufacturers would convert self-contained CRE models to R-290. 88 FR 70196, 70227–70228. The use of R-290 is generally expected to provide higher efficiency performance at the baseline level (compared to current refrigerants), such that the baseline efficiency levels defined in the October 2023 NOPR for each self-contained class generally reflected a lesser energy use than the currently applicable DOE standards for CRE. *Id.* In the October 2023 NOPR, DOE's analysis considered that these efficiency improvements, equipment costs, and manufacturer investments required to comply with the December 2022 EPA NOPR would be in effect prior to the time of compliance for the amended CRE standards for all equipment classes and sizes as proposed in the October 2023 NOPR. *Id.* Therefore, in the October 2023 NOPR, DOE noted that the October 2023 NOPR analysis did not consider benefits and costs resulting from the December 2022 EPA NOPR. *Id.* DOE clarifies that DOE has not double counted any energy savings from the October 2023 EPA Final Rule in the October 2023 NOPR, in the August 2024 NODA, or in this final rule.

In the October 2023 NOPR, DOE requested comment on its proposal to use baseline levels for CRE equipment based upon the anticipated design changes that will be made by manufacturers in response to the December 2022 EPA NOPR. *Id.*

DOE received numerous comments indicating that R-290 may not be suitable for use in large-capacity self-contained equipment—these comments are addressed in the section below discussing large-capacity self-contained equipment using A2L refrigerant. DOE also received comments addressing analysis for smaller self-contained equipment that do not have an issue using R-290—these are addressed in the following section for non-large self-contained equipment using R-290. Additional more general comments regarding the refrigerant transition are discussed in the following paragraphs.

AHRI commented that the new refrigerants must conform to safety standards now being updated and revised, such as ASHRAE 15 and UL 60335-2-89, and these refrigerants are not universally compatible with all end uses covered in EPA's proposed Significant New Alternatives Policy (“SNAP”) approvals, requiring further refinement and other regulatory actions to clear the path forward. (AHRI, No. 81 at p. 2) AHRI cited as an example UL

60335-2-89 Second Edition (2021), which has been proposed for most end uses of A2Ls and a replacement for UL 471. (*Id.*)

AHRI commented that some product types have not switched to R-290, especially large CRE products that require larger charges of R-290, exceeding 150g. (AHRI, No. 81 at p. 8) AHRI commented that technology is just becoming available for larger units as manufacturers are working on preliminary designs to meet the proposed SNAP 26 rule and UL 60335-2-89; AHRI added that until these go into effect, larger charge quantities of R-290 cannot be used. (*Id.*)

Hussmann also pointed out that even though UL 60335-2-89 ed. 2 allows an increased 494 g R-290 charge size, this is not yet approved by SNAP. (Hussmann, No. 80 at p. 5)

In response to the October 2023 NOPR, SCC and AHRI commented that EPA has not published the SNAP Program Rule 26, which approves larger charges for R-290 products and that, currently, the charge limit for R-290 products is 150 grams, which limits the size of these products. (SCC, No. 74 at p. 2; AHRI, No. 81 at p. 5)

Hussmann stated that, because SNAP Rule 26 is still in the proposal stage, Hussmann has been unable to release equipment that uses higher-charge R-290 refrigerant or new A2L refrigerants and, therefore, how these refrigerants impact energy consumption is not yet known. (Hussmann, No. 80 at p. 2)

Hussmann and AHRI commented that DOE should refrain from new rulemakings until SNAP 26 and building codes are updated, and the transition to low-GWP refrigerants is completed, for a better understanding of baseline energy use. (Hussmann, No. 80 at pp. 2–3; AHRI, No. 81 at p. 5) AHRI stated that two key factors in lowering GWP and developing new systems—increased R-290 charge limits and SNAP approval of A2L—are not yet finalized by EPA and these technologies are representative of products retailers will use in 2027. (*Id.*) AHRI commented that, for self-contained products, these options will reduce the number of condensing units per display case (larger model display cases). (*Id.*)

In response, DOE notes that many of the ongoing regulatory and standards processes that were not finalized by the time of publication of the October 2023 NOPR have in the interim been finalized. Most notably, EPA finalized the October 2023 EPA Final Rule and the SNAP 26 Final Rule, which harmonizes with UL Standard 60335-2-89, Edition 2 and ASHRAE 15. 89 FR 50410 (June 13, 2024). Also relevant for

the full capacity range of self-contained CRE, SNAP 26 increased the allowable charge of R-290 from 150 grams in self-contained CRE to 304 grams for closed equipment and 494 grams for open equipment and allows the use of certain A2L refrigerants, such as R-454C and R-455A.

FMI and NACS commented that DOE's assumption that the market will have transitioned to the October 2023 EPA Final Rule in its baseline is overly speculative and that there are challenges related to technical feasibility, availability of installers and service technicians, local codes, and more that will make it impossible for industry to comply with AIM Act regulations within the allotted compliance timeframe. (FMI and NACS, No. 78 at p. 2)

In response to comments about additional time needed for out-of-date building codes to be updated, ACHR News<sup>50</sup> stated that “in the U.S., states usually adopt mechanical codes from either the International Code Council (“ICC”) or the International Association of Plumbing and Mechanical Officials (“IAPMO”).” In May 2024, the ICC published the 2024 I-Codes,<sup>51</sup> including the 2024 International Mechanical Code (“2024 IMC”).<sup>52</sup> The 2024 IMC includes provisions for refrigeration equipment building codes that are commonly adopted by most states, and in the May 2024 version, section 1101.2.1, “Group A2L, A2, A3 and B1 high probability equipment,” states that equipment using Group A2L, A2, A3 or B1 refrigerant shall comply with UL 484, UL/CSA 60335-2-40, or UL/CSA 60335-2-89. Therefore, DOE expects that all States will have updated their building codes to reference the ICC or other equivalent standards to reference updated safety standards by the 2029 compliance year.

In response to the comment from FMI and NACS about market transition to alternative refrigerants, as discussed in section III.A.2.a of this document, NAFEM commented that most self-contained CRE today, in the commercial bar space, already uses alternate refrigerants, (almost exclusively R-290) and stated that they already made the change to R-290 from R-134a more than 5 years ago. (NAFEM, No. 83 at pp. 3–5) Kirby also commented that much of the current equipment incorporates new refrigerants, particularly self-contained models that utilize R-290. (Kirby, No.

<sup>50</sup> See [www.achrnews.com/articles/147113-finalizing-the-a2l-provisions-in-2024-mechanical-codes](http://www.achrnews.com/articles/147113-finalizing-the-a2l-provisions-in-2024-mechanical-codes).

<sup>51</sup> See <http://codes.iccsafe.org/codes/i-codes/2024-icodes>.

<sup>52</sup> See <http://codes.iccsafe.org/content/IMC2024V1.0/chapter-11-refrigeration>.

66 at p. 2) Additionally, DOE notes that over 93 percent of ENERGY STAR equipment have already transitioned to low GWP, hydrocarbon refrigerants.<sup>53</sup> In response to FMI and NACS comment, DOE assumes that manufacturers will comply with applicable regulations. As a result, DOE does not anticipate that the challenges referenced by FMI and NACS will make it impossible for industry to comply with AIM Act regulations within the allotted compliance timeframe.

#### Large-Capacity Self-Contained Equipment Using A2L Refrigerants

This sub-section addresses large-capacity self-contained CRE.

In response to the October 2023 NOPR, Hussmann commented that DOE applied a design option of R-290 variable-speed compressor to classes such as SVO.SC.M that contain some very large models, such as a 12-ft-long by 6-ft-wide shop-around island case with a refrigeration load of approximately 24,000 Btu/hr that Hussmann manufactures. (Hussmann, No. 80 at p. 5) Hussmann stated that not all self-contained product types have been switched over to R-290 yet, especially large CRE that require larger charges of R-290 or an A2L refrigerant. (Hussmann, No. 80 at p. 6) Hussmann recommended that DOE establish baselines with what is currently available in the market. (*Id.*) Hussmann further stated that these models will have to be transitioned to a new A2L refrigerant by January 1, 2025 to comply with the October 2023 EPA Final Rule, so the assumed R-290 energy efficiency improvement in DOE's analysis does not apply. (*Id.*) Hussmann commented that, regarding the self-contained equipment that will transition to an A2L refrigerant, Hussmann anticipates that there is no appreciable reduction in energy consumption based on preliminary lab testing. (*Id.* at p. 6)

Zero Zone stated that DOE only evaluated and tested equipment with relatively small volume, adding that the smaller-volume equipment is not representative of the entirety of the market with self-contained equipment available over 200 ft<sup>3</sup> of volume. (Zero Zone, No. 75 at p. 3)

Zero Zone, Hussmann, and SCC commented that larger volume CRE would require multiple condensing units for R-290. (Zero Zone, No. 75 at p. 3; Hussmann, No. 80 at p. 5; SCC, No. 74 at p. 2) SCC further commented that this would result in compressors with lower EER, given that compressors with lower capacity tend to be less efficient. (SCC, No. 74 at p. 2) Hussmann added that R-290 is not a practical refrigerant to use because multiple separate condensing units/refrigerant circuits would be needed, which is prohibited by a lack of physical space and by product cost constraints. (Hussmann, No. 80 at p. 5)

Zero Zone commented that the use of larger charge propane systems is not as simple as buying and attaching larger units because the safety standards will require additional testing to confirm the larger charge will not be a safety issue for larger charge propane systems. (Zero Zone, No. 75 at p. 4) Zero Zone also commented that equipment with larger charges will need additional mitigation components, including sensors, controls, and fans. (*Id.*) Zero Zone stated that instead of the additional complexity and higher costs of the larger-charge propane systems, end users may want to purchase larger-charge A2L self-contained equipment, and DOE should set energy levels that would allow the use of other refrigerants. (*Id.*)

In the August 2024 NODA, DOE updated its approach for selecting representative units for the engineering analysis from the October 2023 NOPR. 89 FR 68788, 68790. The updated approach was based on feedback, such as the comments summarized in the preceding paragraphs, received from manufacturers and additional analysis conducted since the October 2023 NOPR. This updated approach indicated that larger CRE units, which contain more refrigerant than smaller units, would require more R-290 refrigerant than the maximum allowable charge size specified by UL 60335-2-89. *Id.* For such equipment, manufacturers will likely instead need to implement other low-GWP refrigerant options to comply with the GWP limits in the October

2023 EPA Final Rule. *Id.* In the August 2024 NODA, DOE identified R-454C and R-455A as alternatives that are mildly flammable (designated "A2L") refrigerants currently available and could be used for units with cooling capacities greater than would be achievable using an allowable R-290 charge size. *Id.*

In recognition of this, DOE evaluated the volume or TDA limit which corresponded to the UL standard charge limits based on refrigeration load per cabinet size and refrigerant charge per refrigeration system capacity. Based on the results, in the August 2024 NODA, DOE analyzed two different representative capacities for the following seven equipment classes: VOP.SC.M, SVO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.M, VCT.SC.L, and VCS.SC.L.<sup>54</sup> *Id.* For each of these seven classes, DOE assumed the use of an A2L refrigerant for the large capacities and R-290 for the non-large capacities in the August 2024 NODA. *Id.*

Also, in the August 2024 NODA, DOE analyzed a smaller representative capacity using R-290 refrigerant for the SOC.SC.M equipment class, as compared to the representative capacity proposed in the October 2023 NOPR. *Id.* DOE concluded that the representative capacity analyzed for the SOC.SC.M equipment class in the October 2023 NOPR using R-290 refrigerant exceeds the likely capacity limit for R-290 based on the 304 g charge limit. Instead, DOE analyzed an A2L refrigerant in the August 2024 NODA. *Id.* Updating the representative capacity for SOC.SC.M is consistent with the precedent the March 2014 Final Rule where DOE changed the representative total display area for HCT.SC.I from 5.12 ft<sup>2</sup> in the 2013 NOPR to 4.78 ft<sup>2</sup> in the March 2014 Final Rule.<sup>55</sup>

Table IV.6 presents the seven equipment classes for which DOE analyzed two representative capacities in the August 2024 NODA. In the August 2024 NODA, DOE presented analytical results of this approach for each of these seven equipment classes. *Id.* at 89 FR 68790-68791.

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<sup>53</sup> [www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results](http://www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results) (last accessed Oct. 23, 2024).

<sup>54</sup> The equipment classes are designated by equipment family, condensing unit configuration, and operating temperature. Equipment Families: VOP—Vertical Open; SVO—Semi-Vertical Open;

HZO—Horizontal Open; VCT—Vertical Closed Transparent; HCT—Horizontal Closed Transparent; VCS—Vertical Closed Solid; HCS—Horizontal Closed Solid; SOC—Service Over Counter; CB—Chef Base; PD—Pull Down. Condensing Unit Configurations: RC—Remote Condensing; SC—Self Contained. Operating Temperatures: H—High

Temperature; M—Medium Temperature; L—Low Temperature; I—Ice Cream Temperature.

<sup>55</sup> The 2013 NOPR TSD and 2014 Final Rule TSD are available at: [www.regulations.gov/document/EERE-2010-BT-STD-0003-0051](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0051); [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).



**Table IV.6 Equipment Classes with Two Representative Capacities**

Condensing Unit Configuration	Equipment Family	Operating Temperature (°F)	Equipment Class Designation	Volume ("V") [ft <sup>3</sup> ] or TDA [ft <sup>2</sup> ] Range	Representative Capacity [ft <sup>3</sup> ] or [ft <sup>2</sup> ]
Self-Contained (SC)	Vertical Open (VOP)	≥ 32	VOP.SC.M	TDA ≤ 17	14.93*
				TDA > 17	29.86
	Semivertical Open (SVO)	≥ 32	SVO.SC.M	TDA ≤ 15	12.8*
				TDA > 15	25.6
	Horizontal Open (HZO)	< 32	HZO.SC.L	TDA ≤ 35	12*
				TDA > 35	50
	Service Over Counter (SOC)	≥ 32	SOC.SC.M	TDA ≤ 40	20
				TDA > 40	51*
	Vertical Closed Transparent (VCT)	≥ 32	VCT.SC.M	V ≤ 100	49*
				V > 100	150
		< 32	VCT.SC.L	V ≤ 70	49*
				V > 70	73.5
	Vertical Closed Solid (VCS)	< 32	VCS.SC.L	V ≤ 100	49*
				V > 100	150

\* These representative volumes or TDAs were analyzed in the October 2023 NOPR.

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DOE received no comments indicating that the suggested refrigerated volume or TDA levels delineating transition to the large-capacity range should be changed for any of the seven identified classes, nor that additional classes should have separate large-capacity ranges. Hence, DOE is finalizing these ranges as presented in the August 2024 NODA.

DOE notes that while DOE is amending the standards in this final rule for the non-large capacity ranges for the seven equipment classes listed in table IV., DOE is continuing to analyze the large capacity ranges for these classes. Therefore, DOE is not discussing comment specific to the analysis for the large capacity ranges and is not amending the standards for the large capacity ranges in this final rule.

Therefore, for the seven large self-contained equipment classes, the standards presented in this rulemaking remain the same as the current standards for each respective class. DOE has addressed all cost related comments, including comments about the cost of A2L equipment in section II.B.3 of this document.

#### Non-Large Self-Contained Equipment Using R-290 Refrigerant

This sub-section addresses comments and issues specific to analysis for the self-contained classes determined to be in the smaller capacity range for which R-290 refrigerant is appropriate.

To account for the December 2022 EPA NOPR, DOE proposed that all manufacturers would be able to convert self-contained CRE to R-290 and, therefore, proposed a more stringent efficiency level than the current DOE standard as the analyzed baseline in the

October 2023 NOPR. 88 FR 70196, 70227–70228. DOE initially determined the energy use associated with the defined baseline efficiency levels for each equipment class assuming use of single-speed R-290 compressors, and selecting for the analysis of each representative unit the more-efficient suitably-sized compressor based on data available at the time of the analysis from two commonly used compressor manufacturers. *Id.* at 88 FR 70228. The equipment daily energy use reduction determined for the use of R-290 in baseline models presented in the October 2023 NOPR is shown below in table IV.7. Baseline efficiency levels used in the analysis for these classes were equal to the current DOE energy conservation standard level for the class, expressed in kWh per day, reduced by these percentages, to account for the refrigerant transition.

**Table IV.7 Effect of Use of R-290 on Energy Use in Baseline Models for the October 2023 NOPR Analysis**

Equipment class	Energy use reduction below DOE standard (%)
VOP.SC.M	4.4
SVO.SC.M	9.2
HZO.SC.M	19.5
HZO.SC.L	4.8
VCT.SC.M	18.8
VCT.SC.L	2.8
VCS.SC.M	20.5
VCS.SC.L	8.5
HCT.SC.M	0.0
HCT.SC.L	0.0
HCS.SC.M	20.1
HCS.SC.L	22.1
SOC.SC.M	2.7
VCT.SC.I	0.0
HCT.SC.I	0.0
VCS.SC.I	3.3

In response to the October 2023 NOPR, DOE received several comments on the proposed baseline levels for self-contained equipment.

NEEA and ASAP *et al.* supported the adoption of R-290 as the new baseline for self-contained CRE. (NEEA, No. 89 at p. 5; ASAP *et al.*, No. 79 at p. 4) Kirby commented that much of the current equipment incorporates new refrigerants, particularly self-contained models that utilize R-290. (Kirby, No. 66 at p. 2)

ASAP *et al.*, agreed with DOE's approach but expressed concern that DOE could be underestimating the efficiency improvements, noting that, in the November 2023 Public Meeting, Zero Zone referenced a 40-percent reduction in energy usage for the VCT.SC.M equipment class when using propane compared to 18.8 percent in DOE's analysis. (ASAP *et al.*, No. 79 at p. 4) ASAP *et al.*, commented that underestimating the efficiency gains yielded by switching to propane refrigerant would result in CRE standards that are less stringent (*i.e.*, requiring less additional design options) than anticipated by the engineering analysis. (*Id.*)

In response to the comment from ASAP *et al.* about DOE underestimating energy savings, DOE notes that this was a misunderstanding by Zero Zone that was explained during the November 2023 Public Meeting. (See November 2023 Public Meeting Transcript, No. 64 at pp. 88–89) Zero Zone's comment suggested that they thought that the percentage energy use reduction of the proposed TSL level (roughly 40 percent) was due only to conversion to R-290,

when reduction for the R-290 conversion alone was 18.8 percent.

Zero Zone and AHRI disagreed with DOE's decision to reevaluate energy levels based only on R-290. (Zero Zone, No. 75 at p. 3; AHRI, No. 81 at p. 8) AHRI stated that the engineering analysis worksheet used R-404A as the pre-baseline with the new baseline of EL 0 based on R-290. (*Id.* at p. 8) However, AHRI stated that EL 0 (*i.e.*, the baseline efficiency level) should have been based on R-404A refrigerant and DOE should not assume that all CRE products have been converted to R-290 because this is not yet allowed by the EPA. (*Id.*) AHRI commented that other options currently used include R-450A, R-513A, and R-600a. (*Id.*) AHRI stated that DOE's analysis does not align with UL safety requirements as R-290 cannot be used in cases with shaded pole fan motors. (*Id.*) AHRI added that the speculation in the DOE analysis does not reflect current models; therefore, DOE cannot expand on what options are available. (*Id.*)

NAMA recommended against using baseline levels for CRE based on anticipated manufacturer design changes made in response to the December 2022 EPA NOPR, as design changes for the EPA regulation are not the baseline for an energy efficiency rulemaking. (NAMA, No. 85 at p. 29) NAMA commented that the EPA-proposed regulation requires reductions in GWP, not an automatic effective date for every unit, for every platform, and the December 2022 EPA NOPR is not final; consequently, it would be impossible for NAMA to provide empirical data on the amount of energy

savings assigned to meeting the EPA proposed regulation. (*Id.*)

In response to AHRI suggestions to analyze additional refrigerants other than R-290 for self-contained equipment classes, DOE notes that its analysis assumes prior conversion of refrigerant to meet the October 2023 EPA Final Rule, which requires GWP less than 150. 88 FR 73098, 73149. Both R-450A and R-513A have higher GWPs (601 and 630 respectively),<sup>56</sup> thus they would not be appropriate options to represent an EPA-compliant baseline. DOE also notes that R-600a has similar compressor efficiencies to R-290, and therefore the performance of units using R-290 should be similar to that of those using R-600a. Regarding the comment that not all models have transitioned to R-290, as indicated, the analysis assumption was that a transition to a refrigerant with GWP less than 150 would be required by January 1, 2025—and this requirement was finalized in the October 2023 EPA Final Rule. Consistent with comments that many models have already converted to R-290 (see, *e.g.*, NAFEM, No. 83 at p. 5) and feedback in manufacturer interviews that manufacturers expect the market to transition to R-290 for models for which the charge limits are sufficient, DOE has finalized its analysis assuming conversion to R-290 to meet EPA regulations when charge limits prescribed by UL-60335–2–89 and SNAP would not be exceeded.

NAFEM commented that, as stated during the November 2023 Public

<sup>56</sup> The values included in the text have been calculated as prescribed by the EPA in 40 CFR 64.64.



Meeting, there are several components that must be flame-resistant or spark-proof and available in a number of applications, particularly in fan motors and both the condenser and the evaporator fan motors, as well as other remote sensing equipment. (NAFEM, No. 83 at p. 16) NAFEM pointed out that, for its small manufacturers, parts are not available for being spark-proof and available at R-290, and volumes are so low that they do not intend to put those products in. (*Id.*) NAFEM commented that DOE assumes a complete conversion to R-290, especially in self-contained units, and advised DOE to slow down its process for CRE until the industry has a better understanding of how to meet AIM Act requirements, which do not require R-290. (*Id.*)

In response to the comment from NAFEM about spark-proof components, DOE notes that, in this final rule and consistent with the October 2023 NOPR and August 2024 NODA, DOE has accounted for the cost of spark-proof components. Because DOE has analyzed R-290 as the baseline for all non-large self-contained classes in response to the October 2023 EPA Final Rule, the costs associated with additional components necessary to comply with safety standards for R-290 are incorporated into the core case cost. In addition, DOE has tested units as small as 7 ft<sup>3</sup> utilizing R-290 refrigerant and observed units utilizing R-290 as small as 2.34 ft<sup>3</sup>.<sup>57</sup> Based on that testing, DOE disagrees that parts are not available at low volumes. Further, during the November 2023 Public Meeting, True Manufacturing commented that the technology for self-contained refrigeration to transition to R-290 is already available. (November 2023 Public Meeting Transcript, No. 64 at pp. 74–75)

<sup>57</sup> See [www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration\\_Equipment\\_-\\_Commercial\\_Single\\_Compartment.html#fq=Chilled\\_or\\_Frozen\\_Volume\\_in\\_cubic\\_feet\\_ft3if\\_Applicable\\_d%3A%5B0.33%20TO%202.29%5D&fq=modelNumber%3A''UCF20HC%5C-25''&fq=Basic\\_Model\\_Number\\_m%3A''UCF20HC%5C-25''&q=Product\\_Group\\_s%3A''Refrigeration%20Equipment%20-%20Commercial%2C%20Single%20Compartment''](http://www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial_Single_Compartment.html#fq=Chilled_or_Frozen_Volume_in_cubic_feet_ft3if_Applicable_d%3A%5B0.33%20TO%202.29%5D&fq=modelNumber%3A''UCF20HC%5C-25''&fq=Basic_Model_Number_m%3A''UCF20HC%5C-25''&q=Product_Group_s%3A''Refrigeration%20Equipment%20-%20Commercial%2C%20Single%20Compartment'').

Hoshizaki and Hussmann disagreed with DOE's approach of accounting for only one refrigerant in the baseline. (Hoshizaki, No. 76 at p. 3; Hussmann, No. 80 at p. 6) Hoshizaki commented after reviewing the ENERGY STAR website it found that the top 25 percent of the market uses multiple refrigerants and recommended that DOE should review refrigerants used in each category and size and analyze energy savings for each refrigerant type for each machine type and size. (Hoshizaki, No. 76 at p. 3)

In response to the comments from Hoshizaki and Hussmann, DOE notes that after reviewing the ENERGY STAR website,<sup>58</sup> only two refrigerants used in rated equipment meet the GWP limit finalized in the October 2023 EPA Final Rule: R-600a and R-290. As previously noted in the October 2023 NOPR TSD, DOE is aware of small CRE equipment using R-600a; however, DOE has determined that R-600a has similar refrigeration-cycle efficiency as R-290 and that the performance of CRE using R-290 is representative of CRE using R-600a. Therefore, in this final rule analysis, DOE has determined that the R-290 baseline in response to the October 2023 EPA Final Rule is representative of the alternative refrigerants that may be used in non-large self-contained equipment.

Hillphoenix commented that, according to DOE's engineering spreadsheet, the R-290 versus R-404A efficiency gains attributed to the compressor are 34.7 percent for medium-temperature ("MT") and 5.6 percent for low-temperature ("LT") applications. (Hillphoenix, No. 77 at p. 7) Hillphoenix requested that Copeland, the largest U.S.-based refrigeration compressor manufacturer, compare LT and MT compressor efficiencies. (*Id.*) Hillphoenix commented that, based on Copeland's actual compressor performance and EER data, the percentage in energy savings for R-290 versus R-404A in LT applications averages approximately 14 percent, compared to DOE's value of 5.7 percent, and in MT applications it averages approximately 22 percent, compared to DOE's value of 34.7 percent. (*Id.* at p. 8)

<sup>58</sup> See [www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results](http://www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results).

NAFEM commented that the CRE industry only saw an energy efficiency improvement closer to 10 percent when switching from R-134a to R-290 more than 5 years ago. (NAFEM, No. 83 at p. 5) AHRI commented that, looking at only the refrigerant, its members anticipate that no appreciable reduction in energy consumption will result from transitioning to low-GWP refrigerants. (AHRI, No. 81 at p. 8)

In response to comments from Hillphoenix, NAFEM, and confidential comments received by DOE that the energy use reduction attributed in the October 2023 NOPR analysis to conversion to R-290 may not be appropriate, DOE reviewed new available compressor performance data and updated its analysis. This is similar to DOE's action in the March 2014 Final Rule, in which DOE updated its compressor assumptions in response to comments received on the 2013 NOPR. 79 FR 17725, 17760. Similarly, in this rulemaking, DOE has updated its analysis for the R-290 baseline energy use level. As described above, in the October 2023 NOPR, DOE determined energy use reduction associated with R-290 transition based on the more efficient appropriately-sized compressor option for which performance data was available from two commonly used compressor manufacturers. 88 FR 70196, 70228. However, based on updated compressor data and feedback provided by commenters, in the August 2024 NODA and this final rule, DOE added compressor data from an additional compressor manufacturer and determined energy use reduction using the average rather than best efficiency of appropriately-sized available compressors. 89 FR 68788, 68792. Based on the updated data, on average, the medium-temperature energy savings presented in this final rule are smaller than in the October 2023 NOPR and the low-temperature energy savings presented in this final rule are larger than in the October 2023 NOPR, an adjustment that is consistent with feedback from Hillphoenix. These updated energy savings were presented in the August 2024 NODA and are also shown in table IV. of this final rule.

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**Table IV.8 Reduction in Energy Use of the Baseline Based on R-290 Refrigerants**

Equipment Class	Energy use reduction below DOE Standard – R-290 (%)
VOP.SC.M	1.3
SVO.SC.M	9.7
HZO.SC.M	14.7
HZO.SC.L	2.6
VCT.SC.M	15.1
VCT.SC.L	5.5
VCS.SC.M	19.9
VCS.SC.L	6.1
HCT.SC.M	0.0
HCT.SC.L	0.0
HCS.SC.M	12.6
HCS.SC.L	0.0
SOC.SC.M	11.0
VCT.SC.I	0.0
HCT.SC.I	0.0
VCS.SC.I	6.9

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In response to the August 2024 NODA, Delfield commented that it agrees with DOE's updated compressor approach of using an average EER rather than the best EER value, especially for new compressors whose EER values have not been validated. (Delfield, No. 99 at p. 2) Hillphoenix and the CA IOUs also supported DOE's updated approach. (Hillphoenix, No. 110 at p. 3, CA IOUs, No. 113, at p. 2) Hillphoenix commented that they support DOE's revised compressor energy savings for low and medium temperature applications, and the CA IOUs commented that the updated R-290 compressor efficiency approach provides a more accurate representation of the baseline energy use for R-290 compressors. *Id.*

However, Delfield disagreed with DOE's inclusion of energy efficiency improvements resulting from switching to R-290 refrigerant in the baseline given that most of the industry has already switched to R-290 refrigerant over 7 years ago. (Delfield, No. 99 at pp. 1–2) Delfield further commented that the CRE models that DOE tested and reverse engineered include a combination of HC and HFC/HFO. (*Id.*) Delfield expressed concern that the HFC/HFO units would inflate the baseline energy use. (*Id.*) Delfield requested further explanation of how including R-290 single-speed compressor as an EL 0 for VCS.SC.M

and L classes is not double counting the energy savings attributed to switching to R-290. (*Id.*)

In response to Delfield, the March 2014 Final Rule, which established the current standards that became effective on March 27, 2017, was based on an analysis using the most commonly-used, industry-standard refrigerants at the time of the March 2014 Final Rule. 79 FR 17725, 17754. DOE stated that it considered two refrigerants, R-134a and R-404A, because these are the industry-standard choices for use in the vast majority of commercial refrigeration equipment. 79 FR 17725, 17753. In support of this final rule, DOE reviewed models that are representative of energy use at or near the current standard and found that, for most analyzed equipment classes, R-134a and R-404A are representative. Therefore, to account for the refrigerant transition mandated by the October 2023 EPA Final Rule, DOE developed a baseline for self-contained equipment subject to this final rule using R-290 as the baseline. Because R-290 has a higher refrigeration-cycle efficiency than R-134a and R-404A, DOE reviewed R-290 compressors currently available for CRE and similarly found that R-290 compressors typically have higher EERs than R-134a and R-404A. Therefore, the R-290 baseline developed for this final rule uses less energy than the current standard for most equipment classes. As noted in table IV.8, DOE has analyzed

the current standard as the R-290 baseline for the HCT.SC.M, HCT.SC.L, HCS.SC.L, VCT.SC.I, and HCT.SC.I equipment classes based on DOE's determination that R-290 is representative of baseline CRE for these classes. These findings are also supported by a review of models with these refrigerants certified to DOE's CCD and tested by DOE.

**CRE in Public Spaces**

In response to the October 2023 NOPR, NAMA commented that in order to be compliant with ASHRAE, manufacturers are required to use no more than 114 grams of R-290 for equipment placed in public hallways or lobbies rather than up to 150 grams, and that a 114-gram refrigerant charge will not allow a significant number of machine models to be updated or enlarged, and the leak testing required by the new 60335-2-89 version will likely require a very precise flammable refrigerant sensor that does not exist. (NAMA, No. 85 at p. 7)

NAFEM relayed a comment from one of its members that manufacturers are interested in converting to R-290, but if a piece of equipment is used in a public space, it must meet ASHRAE 15, which limits the actual charge amount to 114 grams, not 150 grams as stated in the October 2023 NOPR TSD and October 2023 NOPR. (NAFEM, No. 83 at p. 16) NAFEM commented manufacturers are limited in size of equipment by that



conversion and cannot convert if the product cannot be sold. (*Id.*)

In response to the comments from NAMA and NAFEM, DOE notes that this same restriction applies to refrigerated bottled- or canned-beverage vending machines (“BVMs”), and DOE has tentatively determined that the 114 g limit would not restrict any currently available BVM units from transitioning to R-290 refrigerant. 88 FR 33968, 33976. While there are differences between the BVM and CRE test procedures and cabinet construction, DOE anticipates that any CRE designed to serve the same market as BVMs (*e.g.*, in public hallways or lobbies) would also be able to transition to R-290 compressors without exceeding the 114g limit.

In addition, commenters did not provide examples of specific models or types of models that are intended for areas of egress and would use more than 114 grams of R-290 refrigerant. DOE reviewed the three VCT.SC.M models under 30 ft<sup>3</sup> using R-290 that it tested, based on NAMA’s request for separate consideration of these models, and found that all three models used less than 114 grams of R-290. The volume of these three models are 8.72 ft<sup>3</sup>, 12.98 ft<sup>3</sup>, and 23.90 ft<sup>3</sup>.

#### Remote Condensing Equipment

In the October 2023 NOPR, DOE noted that remote condensing CRE is also impacted by the December 2022 EPA NOPR, however, in AHRI 1200 the test procedure calculates an expected compressor energy consumption based on the case refrigeration load, independent of the refrigerant type of the compressor. 88 FR 70196, 7028870228. Hence, DOE initially determined that alternative refrigerants in remote CRE cases do not result in changes in measured energy consumption. *Id.*

DOE did not receive comments on this approach, and therefore, consistent with the analysis in the August 2024 NODA, in this final rule DOE is analyzing the current standard as the baseline for remote condensing equipment.

Hussmann commented that, while EPA’s effective date for self-contained equipment classes is January 1, 2025, the effective date for the same equipment classes for remote

condensing products is January 1, 2026 or January 1, 2027, based on the type of connected refrigeration system. (Hussmann, No. 80 at p. 6) Hussmann stated its belief that, for these remote condensing classes, it is too soon to comment on energy use reduction for equipment that will be transitioned to A2L refrigerants not even yet allowed by EPA SNAP and many building codes around the nation. (*Id.*)

In response to the comment from Hussmann on SNAP approval and building codes, as noted in the previous section, SNAP 26 was finalized to allow A2L refrigerants in accordance with UL 60335–2–89 and ASHRAE 15/34. In addition, based on a webinar by AHRI,<sup>59</sup> as of June 2024, only 6 states do not currently allow A2L refrigerants, far fewer than in August 2022 when 36 states did not allow A2L refrigerants. Therefore, DOE anticipates that by the compliance year of 2029 building codes should not impact a manufacturer’s ability to transition to A2L refrigerants.

#### iii. Engineering Assumptions

Appendix 5A of the October 2023 NOPR TSD itemized baseline design details and key engineering assumptions regarding component performance affecting energy use that were used in the engineering spreadsheet analysis of primary equipment class representative units. The October 2023 NOPR notice provides additional discussion regarding baseline designs. 70196, 70228–70230. DOE received comments in response to the baseline engineering assumptions used in the October 2023 NOPR analyses. Specifically, DOE received several comments regarding the insulation R-value, insulation thickness, fan motors, anti-sweat heater controls, lighting, and conduction loads in the engineering analysis for the baseline. The August 2024 NODA and its accompanying support document present revisions made to the analyses that DOE made in response to the October 2023 NOPR comments. DOE received additional comments on these topics in response to the August 2024 NODA. Both the NOPR and NODA comments and DOE’s final determinations regarding baseline design details are discussed in the following paragraphs.

In response to the August 2024 NODA, The CA IOUs commented that they supported the updated baseline design components because these they more accurately reflect current baseline models in the CRE market. (CA IOUs, No. 113, at p. 1)

#### Insulation R-Value

In the October 2023 NOPR engineering analysis, DOE assumed an R-value for polyurethane foam of 8 (ft<sup>2</sup>-°F-hr/Btu) per inch. DOE received the following comments in response.

In response to the October 2023 NOPR, Hussmann commented that DOE’s assumption of the R-value per inch of the equipment insulation is unrealistic, stating that R-values per inch of the foam itself for CRE are much closer to 6.5 per inch than they are to the 8.0 shown in DOE’s engineering spreadsheet.<sup>60</sup> (Hussmann, No. 80 at p. 5) Hussmann agreed with DOE’s determination in the October 2023 NOPR TSD to use an adjusted R-value per inch of 4.0 for the finished foam panels to account for edge effects and gasket heat losses. (*Id.*)

ITW commented that DOE should revise its CRE engineering spreadsheet assumptions to better reflect the current state of the industry in terms of the thermal conductivity of the insulating foam used in the construction of refrigerated cabinets. (ITW, No. 82 at p. 2) ITW commented that the average CRE industry R-value is between 6.3 and 7.1 and that this is backed up by data and a recent NAFEM survey in which 71.5 percent of the CRE manufacturers surveyed reported an R-value for their insulation between 6.4 and 7.4. (*Id.* at p. 3) Based on ITW’s product experience, competitive evaluations, technical data points, and the responses from the NAFEM survey, ITW requested DOE change the baseline R-value from 8 to 6.5. (*Id.* at p. 4)

NAFEM provided results of its manufacturer survey. Results of this summary regarding insulation K factor are summarized in table IV.9. (NAFEM, No. 83 at pp. 38–39)

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<sup>60</sup> The October 2023 NOPR engineering analysis spreadsheet is available at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0055](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0055).

<sup>59</sup> See [www.youtube.com/watch?v=aETuPis5cAM](https://www.youtube.com/watch?v=aETuPis5cAM).

**Table IV.9 NAFEM Survey Results for Insulation K Factor**

K Factor Answer Choices*	R-Value (converted from K factor)*	% of responses	# of Responses
$K \leq 0.125$	$R \geq 8$	14.29	1
$0.125 < K \leq 0.130$	$8 > R \geq 7.7$	0	0
$0.130 < K \leq 0.135$	$7.7 > R \geq 7.4$	14.29	1
$0.135 < K \leq 0.140$	$7.4 > R \geq 7.1$	14.29	1
$0.140 < K \leq 0.145$	$7.1 > R \geq 6.9$	14.29	1
$0.145 < K \leq 0.150$	$6.9 > R \geq 6.7$	14.29	1
$0.150 < K \leq 0.155$	$6.7 > R \geq 6.5$	28.57	2

\* Note that the K factor values provided by NAFEM did not include units and were presented including an additional 0 (*i.e.*, 0.0125 instead of the 0.125, as presented in the table above). Based on other commenter feedback (*i.e.*, ITW, No. 82 at p.3 cited in the preceding paragraph) and typical K values for the CRE industry, DOE has edited NAFEM's survey results to reflect the likely intended values, in units of Btu-in/h-sqft-°F. If the intended units were instead Btu/h-ft-°F, the conductivity ranges would be 20% higher than indicated in the table, and the resistance values correspondingly incrementally lower. However, the former assumption leads to conclusions more consistent with other comments regarding industry-average R-values.

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In response to the comment from Hussmann, DOE notes that the R-value used in the October 2023 NOPR engineering analysis was 8 per inch, not an adjusted R-value of 4.0 per inch. DOE believes that Hussmann was referring to the June 2022 Preliminary TSD, which applied a multiplier of 0.5 to the R-value per inch, resulting in an adjusted R-value of 4.<sup>61</sup> This adjustment was done to adjust the heat load in addition to other adjustments to design specifications for heat load adjustments (*i.e.*, infiltrated air mass flow), however, in the October 2023 NOPR, based on comments in response to the June 2022 Preliminary Analysis, DOE analyzed a revised R-value of 8 per inch with the infiltrated air mass flow to be more consistent with the March 2014 Final Rule. 88 FR 70196, 70234.

In response to comments on the October 2023 NOPR analyzed R-value of 8 per inch, DOE reviewed these comments, and based on this review and consistent with commenter feedback, DOE presented a revised analysis in the August 2024 NODA with the R-value of polyurethane foam changed from 8 per inch to 6.5 per inch to represent the baseline R-value used by CRE models. 89 FR 68788, 68792.

In response to the August 2024 NODA, Hussmann agreed with DOE's update of the insulation R-value from 8 per inch to 6.5 per inch, as this is in line with the R-value of polyurethane blown foams used in the CRE market. (Hussmann, No. 108 at p. 2) Continental, AHRI, Hillphoenix, Delfield, and ITW also commented in support of DOE's updated R-values from 8 to 6.5 per inch. (Continental, No. 107

at p. 2; AHRI, No. 104 at p. 8; Hillphoenix, No. 110 at p. 4; Delfield, No. 99 at p. 2; ITW, No. 111 at p. 1)

In this final rule, DOE is maintaining 6.5 per inch to represent the baseline R-value used by CRE models.

**Insulation Thickness**

Several commenters expressed concerns with the insulation thickness analyzed in the October 2023 NOPR. For ease of reference, Evaporator Fan Control shows the insulation thickness assumed for each equipment class in the March 2014 Final Rule, the June 2022 Preliminary Analysis, and the October 2023 NOPR and the updated insulation thickness analyzed in this final rule, which is the same as presented in the August 2024 NODA.

<sup>61</sup> See table 5.5.4 of the Preliminary Analysis TSD, available at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0016](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0016).



**Table IV.10 Comparison of Insulation Thickness Analyzed in the March 2014 Final Rule, June 2022 Preliminary Analysis, October 2023 NOPR, August 2024 NODA, and this Final Rule**

<b>Equipment Class</b>	<b>2014 Final Rule</b>	<b>Preliminary Analysis</b>	<b>NOPR</b>	<b>Final Rule (same as August 2024 NODA)</b>
VOP.RC.M, VOP.SC.M, SVO.RC.M, SVO.SC.M, SOC.RC.M, SOC.SC.M	1.5	1.5	2	1.5
CB.SC.M	-	2	2	1.5
VOP.RC.L	2	2	2	2
CB.SC.L	-	2.5	2	2
HZO.RC.M, HZO.SC.M, VCT.RC.M, VCT.SC.M, VCS.SC.M, HCT.SC.M, HCS.SC.M	1.5	1.5	2.5	1.5
VCT.SC.H, VCS.SC.H	-	1.5	2.5	1.5
HZO.RC.L, HZO.SC.L, VCT.RC.L, VCT.SC.L, VCS.SC.L, HCT.SC.L, HCS.SC.L	2	2	2.5	2
VCT.SC.I, VCS.SC.I, HCT.SC.I	2.5	2.5	2.5	2.5

In response to the October 2023 NOPR, AHRI, SCC, and Hillphoenix stated that despite screening out increased insulation thickness as a design option, DOE has increased the 2023 baseline insulation thickness from the March 2014 Final Rule selected design levels. (AHRI, No. 81 at p. 7; Hillphoenix, No. 77 at pp. 3–4; SCC, No. 74 at p. 3) Hillphoenix also commented that equipment used to manufacture insulated structures is typically used to produce products in multiple covered DOE classes, therefore changes in insulation thickness of one equipment class would require changes in multiple classes, resulting in an increase in testing, recertification, and validation. (Hillphoenix, No. 77 at p. 4)

NAMA, Hussmann, and ITW commented that the insulation thickness assumed in the October 2023 NOPR is not representative of CRE products on the market today. (NAMA, No. 85 at p. 5; Hussmann, No. 80 at p. 4; ITW, No. 82 at pp. 2, 5) ITW commented that it is contradictory that DOE screened out increased insulation as a design option but have included an additional 0.5 inches of insulation in the baseline calculation for CRE in the October 2023 NOPR compared to the June 2022 Preliminary TSD. (ITW, No. 82, at p. 5)

NAMA stated that 1 inch to 1.5 inches is typical of nearly all machines including VCT.SC.M equipment. (NAMA, No. 85 at pp. 5, 15) Hussmann

stated that the standard insulation thickness for medium-temp commercial refrigeration equipment is 1.5 inches and for low-temp equipment is 2.0 inches, and this should be considered when determining the energy limits. (Hussmann, No. 80 at p. 4) ITW requested that DOE change the baseline insulation thickness from 2.5 inches to 2.0 inches. (ITW, No. 82, at pp. 2, 5)

NAFEM provided results of a survey of its manufacturers for the insulation thickness in its units, which is presented in Table IV.. (NAFEM, No. 83 at pp. 36–37) DOE notes that the survey results provided by NAFEM do not specify the operating temperature of the surveyed equipment.

**table IV.11 NAFEM Survey Results for Insulation Thickness**

Range of Insulation Thickness for models 49–60 ft <sup>3</sup> [in]	% of Responses	# of Responses
$X \leq 1.5$	28.57	2
$1.5 < X \leq 1.75$	28.57	2
$1.75 < K \leq 2$	14.29	1
$2 < K \leq 2.25$	28.57	2
$2.25 < K \leq 2.5$	0.0	0

DOE reviewed comments in response to the October 2023 NOPR that requested that DOE review the baseline assumptions. Based on these comments, DOE presented a revised analysis in the August 2024 NODA. 89 68788, 68792. DOE has revised the insulation thicknesses to be consistent with the insulation thicknesses analyzed in the March 2014 Final Rule,<sup>62</sup> which are also consistent with comments received in response to the October 2023 NOPR, including the survey results presented by NAFEM, and DOE's reverse engineering data. DOE's engineering analysis is based on the following updated insulation thicknesses: medium- and high-temperature equipment with an insulation thickness of 1.5 inches, low-temperature equipment with an insulation thickness of 2.0 inches, and ice cream temperature equipment with an insulation thickness of 2.5 inches. See table IV.10 presented at the beginning of this section for further details.

In response to these updates in the August 2024 NODA, Hillphoenix and ITW agreed with DOE's decision to align insulation R-values and thickness to reflect current industry offerings. (Hillphoenix, No. 110, p. 4; ITW, No. 111 at p. 1) DOE has maintained these insulation thickness values in this final rule.

#### Fan Motors

In the October 2023 NOPR, DOE assumed a combination of ECM, shaded pole, and permanent split capacitor ("PSC") evaporator, and condenser fan motors in the baseline representative unit, depending on the equipment class. For more details about the baseline evaporator and condenser fan motor types assumed in the October 2023

NOPR, see tables 5A.2.1 through 5A.2.4 of the October 2023 NOPR TSD.

In response to the October 2023 NOPR, NAMA, AHRI, Hussmann, and SCC commented that ECMs are already widely in use in the CRE industry since the 2017 standards. (NAMA, No. 85 at pp. 14, 23; AHRI, No. 81 at pp. 4–5; Hussmann, No. 80 at p. 4; SCC, No. 74 at p. 1) NAMA added that ECMs have been used in CRE designs for at least 5 years and several of its companies mentioned that they have been using ECM condenser and evaporator fan motors since 2013. (NAMA, No. 85 at pp. 14, 23) Hussmann and NAMA stated that DOE's baseline component assumptions should reflect the widespread use of ECMs. (Hussmann, No. 80 at p. 4; NAMA, No. 85 at p. 23) NAMA commented that this design option applies to VCT.SC.M units, and also VOP, and HZO units. (NAMA, No. 85 at p. 23) NAMA further commented that the savings achieved from transitioning to ECMs was in the vicinity of 2–2.5-percent improvement when it was introduced, adding that they agreed with DOE that the savings would be in the vicinity of 0.139 kWh/day. (*Id.*)

With respect to the comments from NAMA, AHRI, Hussmann, and SCC, DOE has reviewed the CRE teardown data it conducted on analysis units in support of this rulemaking and observed that a significant number of units, but not all units, contained ECM evaporator and condenser fan motors. Therefore, based on DOE's teardown data and consistent with commenters' feedback, DOE updated its assumptions regarding baseline fan motors for certain equipment classes in the August 2024 NODA. The analysis sets ECM as the baseline evaporator and condenser fan motor type for most equipment classes, but not all classes, which is consistent with the data available to DOE.

In response to the August 2024 NODA, Continental agreed with DOE's

revised use of ECMs as the baseline, and stated that this revision should be applied to all equipment classes.

(Continental, No. 107 at p. 2) Continental additionally stated that it does not utilize shaded pole ("SP") motors in any R–290 products due to safety concerns and attempts to maximize product performance. (*Id.*)

ITW also commented in support of DOE's revised assumption that current CRE already incorporates the use of electronically commutated motors for evaporator and some condenser fan applications, and that revised efficiency levels now take this into consideration. (ITW, No. 111 at p. 1)

Hussmann and AHRI also agreed with DOE's assumption that EC fan motors should be the baseline fan motor assumption for the vast majority, if not all, equipment classes. (Hussmann, No. 108 at p. 2; AHRI, No. 104 at p. 8)

AHRI disagreed with DOE's assumption that shaded pole fan motors are used as the baseline for self-contained equipment using R–290 as a refrigerant, *e.g.*, in the SOC.SC.M class, noting that SP motors are considered potential ignition sources for a flammable mixture of R–290 and air that could be created in a leak scenario. (AHRI, No. 104 at p. 8) AHRI stated that it has always opted for EC fan motors for both the evaporator and condenser when using R–290. (*Id.*) AHRI stated that the additional cost of EC motors is worth the reduction in risk and avoidance of additional safety testing required by the UL standards when shaded pole motors are used with R–290. (*Id.*)

Delfield commented that several OEMs already use DC condenser fans and expressed concern that DOE expects savings on something that is already implemented to meet current energy regulations. (Delfield, No. 99 at p. 2) Delfield added that they have several units using DC fans that barely make current regulations so any reduction

<sup>62</sup> See Table 5A.2.2 Baseline Specifications in the March 2014 Final Rule TSD at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).



would likely prevent them from selling those products that are currently in demand from customers. (*Id.*)

Regarding the comment from Delfield, in this final rule DOE has analyzed ECM as the baseline evaporator and condenser fan motor type for most, but not all, equipment classes, consistent with the data available to DOE. In response to AHRI's comment about the use of shaded pole motors with R-290 refrigerant, DOE notes that these motors can be enclosed to be suitable for use with R-290, but agrees it may be more cost-effective to switch to ECM motors. On the other hand, the switch to ECM motors would make the model more efficient than simply converting the refrigerant. Rather than assume a manufacturer would, in response to the EPA October 2023 final rule requiring use of low-GWP refrigerants, implement ECMs on top of converting the refrigerant, thus achieving a higher efficiency as a post-refrigerant-transition baseline, DOE instead assumed that the baseline should be based only on the refrigerant conversion. For further details, see section 2, "Design Specifications and Baseline Design Options" in the NODA support document (see EERE-2017-BT-0007-0090 at pp. 10–14).

#### Anti-Sweat

In response to the October 2023 NOPR, Hillphoenix commented that, DOE utilized different amounts of anti-sweat heat for remote vs. self-contained equipment classes for the equipment classes SOC.SC.M and SOC.RC.M with the same case design options. (Hillphoenix, No. 77 at p. 4) Hillphoenix commented also that these two equipment classes are identical products (with the exception of an added compressor) and should use the same amount of anti-sweat wattage. (*Id.*) Hillphoenix stated that in DOE's engineering spreadsheet for the October 2023 NOPR, the self-contained class uses 90 watts of heat versus the remote class's 200 watts, and the lower wattage in the self-contained class will create sweating and condensation issues. (*Id.*) Hillphoenix stated that this violates the prohibition in EPCA of adopting energy standards that impair the functionality of a pre-existing product. (*Id.*)<sup>63</sup>

<sup>63</sup> EPCA states the following at 42 U.S.C. 6295(o)(4): the Secretary may not prescribe an amended or new standard under this section if the Secretary finds (and publishes such finding) that interested persons have established by a preponderance of the evidence that the standard is likely to result in the unavailability in the United States in any covered equipment type (or class) of performance characteristics (including reliability), features, sizes, capacities, and volumes that are substantially the same as those generally available

In response to Hillphoenix, DOE notes that, in the section 5.5.2 of the October 2023 NOPR TSD, DOE stated that the anti-sweat heater assumptions were based on data from directly analyzed units and manufacturer feedback. However, based on additional test data and feedback from commenters, DOE has updated the anti-sweat heater power for the SOC.SC.M class in this final rule, consistent with the August 2024 NODA. As indicated in the NODA support document, DOE revised its anti-sweat wattage assumptions in the August 2024 NODA analysis such that the wattages for the self-contained and remoted condensing service-over-counter models with 51 sq.ft. TDA are nearly the same at 190 W and 200 W, respectively (see table 2.9 for SOC.RC.M table 2.10 for SOC.SC.M).

Zero Zone commented that reduced energy levels will result in equipment designs with very low energy anti sweat heaters, which will be more likely to have condensate on surfaces because many end users do not have reliable humidity control on the store air conditioning. (Zero Zone, No. 75 at p. 4) Zero Zone commented also that customers will request anti-sweat heaters with higher power and, therefore, manufacturers will need to apply anti-sweat heater controllers. (*Id.*) Zero Zone stated that DOE should add the cost of anti-sweat controllers to the equipment cost when DOE calculates payback and energy savings. (*Id.*)

With respect to the comment from Zero Zone about additional costs associated with anti-sweat heater controllers, DOE has revised the anti-sweat heater powers assumed in the baseline for this final rule, which are consistent with the CRE market and are designed to prevent condensation buildup on surfaces. Therefore, DOE has determined that anti-sweat heater controllers are not required for baseline equipment in this final rule analysis. Additionally, DOE included neither anti-sweat heater controllers nor anti-sweat heat wattage reduction as design options in the August 2024 NODA analysis. DOE did not analyze additional cost for anti-sweat heater controllers because this was not considered as a design option.

DOE did not receive any comments in response to the August 2024 NODA which suggested alternative baseline anti-sweat heater wattages. Thus, DOE

in the United States at the time of the Secretary's finding and the failure of some types (or classes) to meet this criterion shall not affect the Secretary's determination of whether to prescribe a standard for other types (or classes). (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(4))

used the same wattage values for the final rule analysis.

#### Lighting for the HZO Equipment Family

In the October 2023 NOPR, DOE updated the lighting design specifications based on data available at that time to account for the energy consumed per foot of LED lights.<sup>64</sup> DOE received several comments in response to this update for the HZO equipment class.

In response to the October 2023 NOPR, NAMA and Hussmann stated that DOE applied lighting control design options to HZO equipment, which typically does not have lighting. (NAMA, No. 85 at p. 24; Hussmann, No. 80 at p. 5)

In response to the comments from NAMA and Hussmann, DOE reviewed its CRE test data for HZO units and observed that lighting is not included for them. Therefore, based on DOE's test data and commenter feedback, DOE removed lighting from the baseline design specifications, and the lighting control design option, for the HZO equipment class in its August 2024 NODA analysis. For further details, see the August 2024 NODA support document, (Tables 2.6, 2.7, 2.10, 3.8, 3.9, 3.22, 3.23, and 3.38). Additionally, DOE notes that updating the lighting design specifications for the HZO equipment family is consistent with the approach in the March 2014 Final Rule, where DOE updated the number of bulbs in the conditioned space for PD.SC.M from 2 to 3.<sup>65</sup>

DOE did not receive comments regarding lighting design specifications in response to the August 2024 NODA. Hence, DOE used the same lighting design specifications for its final rule analysis.

#### Conduction Loads

In response to the October 2023 NOPR, ITW commented that DOE should revise its CRE engineering spreadsheet assumptions to account for ancillary transmission losses (*i.e.*, conduction loads through thermal breaks, drain tubes, refrigerant lines, screws, bolts, internal assembly flanges, etc.). (ITW, No. 82 at p. 2) ITW stated that the accounting for these ancillary losses was dropped out between the June 2022 Preliminary Analysis and the October 2023 NOPR versions of the CRE engineering spreadsheet. (*Id.*) Specifically, ITW requested that DOE revert to the assumptions from the June

<sup>64</sup> See section 5.5.8.2 and appendix 5A.2 of the October 2023 NOPR TSD.

<sup>65</sup> See tables 5.A.2.2 of the NOPR and March 2014 Final Rule TSD available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).

2022 Preliminary Analysis engineering spreadsheet, where it included a 50-percent multiplier to calculate the adjusted R-value and, therefore, more properly account for these ancillary losses. (*Id.*)

With respect to the comment from ITW, DOE notes that, in this final rule analysis, DOE analyzed a revised R value of 6.5, which is on the low end of survey results provided by NAFEM. In addition, DOE calibrated the design specifications in the engineering spreadsheet to be representative of all units in each equipment class and account for a variety of factors that could affect energy use. Therefore, DOE has determined that an adjustment factor to the insulation thickness is not necessary for this final rule. As previously noted in the Insulation R-Value section, while DOE did include a 0.5 adjustment factor for the R-value in the June 2022 Preliminary Analysis, along with updates to infiltrated air-mass flow, DOE received feedback disagreeing with the infiltrated airflow approach in response to the June 2022 Preliminary Analysis. 88 FR 70196, 70234. Based on this feedback and feedback provided during manufacturer interviews, DOE re-evaluated the infiltrated-air mass flow and insulation design specifications in the October 2023 NOPR to be more consistent with the March 2014 Final Rule, *i.e.* increasing the infiltrated air assumptions for the October 2023 NOPR analysis as compared to the June 2022 Preliminary Analysis. *Id.* As a result,

DOE determined that an R-value adjustment factor would have resulted in calculation of energy use far higher than the baseline for representative equipment designs in the October 2023 NOPR analysis. DOE similarly determined that an R-value adjustment factor would have been inappropriate for the August 2024 NODA analysis and did not apply such a factor.

DOE did not receive comments regarding conduction loads in response to the August 2024 NODA. Hence, DOE used the same input assumptions affecting conduction loads for its final rule analysis.

#### Other Engineering Assumptions

In response to the October 2023 NOPR, DOE received comments on several other proposed baseline engineering assumptions.

AHRI requested that DOE review the engineering analysis based on current technology in the field. (AHRI, No. 81 at p. 7)

NAMA commented that the assumptions about efficiency options outlined in the October 2023 NOPR TSD are deeply flawed, as are the baseline efficiency levels. (NAMA, No. 85 at p. 5) NAMA stated that current units at baseline already utilize LED lighting, higher efficiency compressors, higher efficiency fan motors, a high-performance door, and several other design options which have been used for the last several years, and that the design option list is therefore based on inaccurate baseline assumptions. (*Id.*)

NAMA further commented requesting that DOE conduct a complete revision of its engineering analysis and all of the downstream analyses to show the very real impacts of standards in the October 2023 NOPR as well as in the August 2024 NODA. (*Id.* at p. 19) (NAMA, No. 112 at pp. 9) In response to the August 2024 NODA, NAMA further commented that it was disappointed in the accuracy of the design changes. (NAMA, No. 112 at p. 7) NAMA added that DOE did not substantially change the August 2024 NODA TSD based on NAMA's comments on the October 2023 NOPR TSD (NAMA, No. 112 at p. 7) NAMA added that DOE said that the August 2024 NODA analysis was updated in response to NAMA's comments on the October 2023 NOPR, however, it is not clear where the cost or energy efficiency pertaining to NAMA products has been updated. (*Id.*)

In addition, DOE received confidential comments requesting that DOE review certain baseline assumptions in the October 2023 NOPR.

In response to the comments from AHRI, NAMA, and the anonymous confidential commenter, in this final rule, DOE has revised certain baseline components and design specifications not already discussed in this section. Table IV.12 shows every baseline design specification that was updated in this final rule, consistent with the August 2024 NODA. For more details, see appendix 5A of the final rule TSD.

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**Table IV.12 Updates to Baseline Engineering Assumptions**

Baseline Engineering Assumptions Updated in Final Rule							
Equipment Class	Insulation Thickness	Length of LED(s) in the Conditioned Space	Number of Evaporator Fans	Infiltrated Air Mass Flow Rate	Discharge Air Temperature	Baseline Evaporator Temperature	Additional
VOP.RC.M	X			X			
VOP.RC.L				X			
VOP.SC.M	X	X		X			
SVO.RC.M	X	X					
SVO.SC.M	X	X					
VCT.RC.M	X	X					
VCT.RC.L	X	X		X			
VCT.SC.H	X	X			X		
VCT.SC.M	X	X			X	X	
VCT.SC.L	X	X			X	X	
VCT.SC.I		X					
VCS.SC.H	X				X		
VCS.SC.M	X				X	X	Non-Door Anti-Sweat Power
VCS.SC.L	X					X	Non-Door Anti-Sweat Power
HCT.SC.M	X	X					
HCT.SC.L	X			X			Compressor Oversize Multiplier
HCT.SC.I		X		X			Compressor Oversize Multiplier
HCS.SC.M	X			X	X	X	Evaporator Fan Shaft Power
HCS.SC.L	X			X			Compressor Oversize Multiplier
CB.SC.M	X			X	X	X	Baseline Condenser Temperature, Compressor Oversize Multiplier
CB.SC.L			X	X			
HZO.RC.M	X	X	X				Number of Ballasts NOT in Conditioned Space, Evaporator Fan Shaft Power
HZO.RC.L	X	X	X				Number of Ballasts NOT in Conditioned Space
HZO.SC.M	X	X					Number of Ballasts NOT in Conditioned Space
HZO.SC.L	X	X					Number of Ballasts NOT in Conditioned Space
SOC.RC.M	X	X					
SOC.SC.M	X	X	X	X			Case Gross Refrigerated Volume, Case Length, Case Total Display Area, Number of Doors, Non-Door Glass Area, Non-Door Anti-Sweat Power, Wall Area, Evaporator Fan Shaft Power, Condenser Fan Shaft Power, Number of Condenser Fans

changed certain baseline design specifications between the NOPR and the final rule. For example, in the March 2014 Final Rule, DOE updated: the number of bulbs in the conditioned space for PD.SC.M from 2 to 3 and the number of ballasts not in the conditioned space from 0 to 1, the non-door anti-sweat power for VCS.SC.M from 0W to 20W, the evaporator fan shaft power, condenser fan shaft power for VCT.SC.M from 6W to 9W and from 6W to 16W respectively, the number of fans for VCT.SC.M from 2 condenser fans to 1 condenser fan, the infiltrated air mass flow rate for VCT.SC.M from 10.61 lb/hr to 13.7 lb/hr, the evaporator temperature conditions for VCT.SC.M from a baseline evaporator temperature of 27 °F to 23 °F, and the compressor oversize multiplier for VCT.SC.M from 1.3 to 2.6.<sup>66</sup>

#### b. Higher Efficiency Levels

As part of DOE's analysis, the maximum available efficiency level is the highest efficiency unit currently available on the market. DOE also defines a "max-tech" efficiency level to represent the maximum possible efficiency for a given product.

In response to the October 2023 NOPR, ASAP *et al.* generally supported the engineering analysis but stated that there are some equipment classes where the max-tech levels are exceeded by a significant number of models on the market today. (ASAP *et al.*, No. 79 at p. 1) Thus, ASAP *et al.* encouraged DOE to further investigate these products and consider whether higher standards may be appropriate. (*Id.*)

ASAP *et al.* encouraged DOE to evaluate max-tech levels that are at least as high as the most efficient models available on the market. (*Id.* at p. 3) ASAP *et al.* commented that for several of the equipment classes analyzed, many models available on the market using R-290 refrigerant appear to exceed the max-tech efficiency level, including many ENERGY STAR-rated models for the VCS.SC.L equipment class, which represents 10 percent of CRE shipments. (*Id.*) ASAP *et al.* also pointed to DOE's CCD, which shows available models for the SVO.SC.M, VOP.RC.M, and SOC.RC.M that also exceed DOE's max-tech levels. (*Id.*) ASAP *et al.* commented that for several of these equipment classes (e.g., VCS.SC.L, SVO.SC.M, VOP.RC.M), DOE has proposed to adopt the max-tech level as evaluated in the engineering

analysis, suggesting that if DOE were to evaluate higher efficiency levels for these equipment classes, it is plausible that these higher levels would be cost-effective for purchasers. (*Id.*)

In response to the comment from ASAP *et al.*, DOE reviewed certified CRE models currently available on the market that exceed the efficiency of the max-tech levels proposed in the October 2023 NOPR and found several potential explanations as to why certain models use less energy than the proposed and final max-tech levels. DOE observed a range of lighting powers for units with similar volumes, with some units using very low light compared to the industry average. DOE also noted differences in insulation thickness that exceeded the industry average. Additionally, DOE noted examples of units rated to the CCD using evaporator fan controls, particularly for units that are not intended to store perishable food or beverages. Evaporator fan controls are not considered as a design option in the final rule analysis, so they are not considered in the final rule max-tech level (see section IV.B.1.f of this document). DOE also found examples of units that exceed the max-tech efficiency levels due to unique technologies which other manufacturers may not be able to adopt. Based on this review, DOE has not found higher standards to be appropriate.

In response to the October 2023 NOPR, NAMA disagreed with DOE's energy saving estimates and design option levels for vertical, self-contained, transparent doors, medium temperature, and other categories using similar options. (NAMA, No. 85 at pp. 10, 11–12) NAMA commented that, according to its screening analysis, DOE presents inaccurate energy savings resulting from changes to more energy-efficient condenser fan motors, variable-speed compressors, occupancy-based lighting controls, triple-pane glass doors, insulation in door glass, and microchannel condensers. (*Id.* at pp. 11–12) NAMA commented also that DOE's estimate of 26.9-percent energy savings in the case of using design options 2–7 is overstated by a factor of at least three. (*Id.* at p. 12) NAMA stated that once design options that DOE has double counted (e.g., DC condenser fan motors) are eliminated, the real estimate should result in a minimum energy standard that returns at 9 percent rather than 26.9 percent. (*Id.*) NAMA further commented that this also applies to categories such as VOP, SC, M and HZO, SC, and L. (*Id.*)

In response to the October 2023 NOPR, AHRI and Hoshizaki stated that it is unclear how DOE determined that

manufacturers are able to reach a 55-percent reduction in energy use in the energy use analysis and DOE should clarify how this reduction can be achieved. (AHRI, No. 81 at p. 9; Hoshizaki No. 76 at p. 4)

In response to the October 2023 NOPR, Hoshizaki requested that DOE review any section showing a reduction of 15 percent or more to verify that these numbers are accurate due to the high requirement that must be met. (Hoshizaki, No. 76 at p. 4)

In response to the October 2023 NOPR, Hillphoenix, Hoshizaki, and NAFEM commented that the design options at the higher efficiency levels are not technologically feasible or cost-effective. (Hillphoenix, No. 77 at p. 1; Hoshizaki, No. 76 at p. 4; NAFEM, No. 83 at pp. 7–8)

As discussed in section IV.C.1.a of this document, after considering the comments received in response to the October 2023 NOPR, DOE has considered revised set of baseline components and design specifications in this final rule. In addition, DOE has also considered changes to design options analyzed beyond baseline based on feedback as discussed in the following sections.

#### Design Options Not Directly Analyzed

As described in section IV.B.2 of this document, defrost controls and variable-speed fan motors did not meet the criteria for screening them out. However, some design options are not considered in the engineering analysis and are categorized as design options not directly analyzed. As described in sections 5.5.8.7 and 5.5.8.10 of the October 2023 NOPR TSD, variable-speed fan motors and defrost controls, respectively, were considered design options not directly analyzed. In response to the October 2023 NOPR, DOE received several comments regarding these design options.

##### i. Defrost Controls

As described in section 5.5.8.10 of the October 2023 NOPR TSD, defrost controls were considered a design option not directly analyzed.

In response to the October 2023 NOPR, the CA IOUs recommended that DOE consider adaptive defrost as a design option for CRE because it is a cost-effective option that will reduce the energy consumption of refrigeration units. (CA IOUs, No. 84 at pp. 5–6) The CA IOUs commented that adaptive defrost saves energy by using less resistance heat and reduces the need for refrigeration energy to cool down the unit afterward. (*Id.* at p. 5) The CA IOUs commented that three major CRE

<sup>66</sup> See tables 5.A.2.2 of the 2013 NOPR and 2014 Final Rule TSD available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0051](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0051) and [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).



manufacturers offer low-temperature models with adaptive defrost and that DOE's 24-hour test procedure based on ASHRAE 72 should demonstrate the energy-saving benefits of adaptive defrost over standard automatic timed defrost. (*Id.* at pp. 5–6) The CA IOUs commented that although many manufacturers use timers for defrost initiation and air temperature for defrost termination, this method differs from the adaptive defrost method, which reduces the equipment's energy use by decreasing the number of unnecessary defrost cycles. (*Id.* at p.6)

As discussed in chapter 5 of this final rule TSD, defrost cycle control can reduce energy consumption by reducing the frequency of the defrost period. While DOE considered variable defrost as a design option in the June 2022 Preliminary Analysis, DOE tentatively determined not to directly analyze this design option in the October 2023 NOPR. 88 FR 70196, 70232. Full defrost cycle control would involve a method of detecting frost buildup, which can be accomplished through an optical sensor or sensing the air temperature differential across the evaporator coil, and initiating defrost only as often as required. However, DOE understands that there is uncertainty for both of these methods due to potential fouling of the coil with dust and other surface contaminants, which becomes more of an issue as cases age. If the sensor driving the adaptive defrost malfunctions, the resulting freezing of the coils is difficult to reverse. Therefore, due to the current uncertainty and lack of test data, DOE maintained the same approach and did not consider variable approach as a design option in this final rule. See chapter 5 of the final rule TSD for more information.

#### ii. Variable Speed Fan Motors

As described in chapter 5, section 5.5.8.7 of the October 2023 NOPR TSD, variable-speed fan motors were considered a design option not directly analyzed.

In response to the October 2023 NOPR, the CA IOUs recommended that DOE consider variable-speed condenser fan controls as a cost-effective technology option for self-contained equipment classes. (CA IOUs, No. 84 at p. 5) The CA IOUs commented that variable-speed condenser fan controls, like variable-speed compressors, can modulate capacity under partial refrigeration load during compressor operations. (*Id.*) The CA IOUs commented also that while variable-speed condenser fans may not provide the same energy savings as variable-

speed compressors, they are much less expensive, and DOE has considered variable-speed condenser fan control a viable and cost-effective technology option for walk-in coolers and freezers ("WICFs.") (*Id.*) The CA IOUs stated that the energy savings and cost effectiveness of variable-speed condenser fan control should be comparable between WICFs and CRE. (*Id.*) The CA IOUs additionally commented that variable-speed condenser fan controls are not applicable for remote condensed equipment classes because the rack compressor systems are not covered products. (*Id.*)

With respect to the comment from the CA IOUs, DOE notes that, in a Final Rule amending energy conservation standards for WICFs, variable-speed condenser fans for WICF dedicated condensing units were considered only for those dedicated condensing units located outdoors, in which the fan speed is reduced during cool outdoor conditions when less airflow is needed to cool the condensing refrigerant. See chapter 5 of the WICF Final Rule TSD for more details.<sup>67</sup> The technology would not achieve similar savings for self-contained systems located indoors, where the fan speed is set appropriate for the relatively constant difference in temperature between the condensing refrigerant and the ambient air. For this reason, DOE has not considered variable-speed condenser fans as a design option to improve the efficiency of CRE in this final rule.

#### Design Options Directly Analyzed

DOE received several comments stating that directly analyzed design options in the October 2023 NOPR were already in use for baseline equipment.

Hoshizaki, Hillphoenix, AHRI, NAFEM, SCC, Kirby, and an individual commenter expressed concern that many of the technologies presented in the October 2023 NOPR analysis have already been implemented in CRE to meet the 2017 regulations. (Hoshizaki, No. 76 at p. 3; Hillphoenix, No. 77 at pp. 1, 11; AHRI, No. 81 at pp. 4–5; SCC, No. 74 at p. 2; Kirby, No. 66 at pp. 1–2; Individual Commenter, No. 70 at p.1) Kirby, Zero Zone, NAMA, and an individual commenter stated that DOE has overestimated the achievable efficiency levels in the proposed rule because many of the efficiency options are already in use. (Kirby, No. 66 at pp. 1–2; Zero Zone, No. 75 at pp. 3, 4; NAMA, No. 85 at p. 5; Individual

Commenter, No. 70 at p.1) NAMA commented that DOE is taking additional credit for energy efficiency by adding certain technologies (*i.e.*, LED lighting, brushless DC evaporator fan motor, high-performance door, and brushless DC condenser fan motor) beyond the baseline to justify the proposed efficiency levels, essentially doubling the energy efficiency benefits from technologies already in use and the future design options in the October 2023 NOPR TSD. (NAMA, No. 85 at p. 6) NAMA stated that following the removal of the design options that are not technically feasible or were accomplished many years ago, it becomes clear that the actual energy savings from the remaining items might result in a baseline energy reduction of 5–10 percent, which is a significant deviation from the 41 percent estimated by DOE. (*Id.* at p. 9)

Zero Zone commented that its large self-contained propane display freezers and coolers (*e.g.*, VCT–SC–L, VCT–SC–M), which already include propane fixed-speed compressors, ECM evaporator and condenser fan motors, triple-pane high-efficiency doors with no glass heat, and 2.5-inch insulated panels and LED lights are able to meet current DOE energy levels, and the addition of variable-speed motors and motions sensors are unlikely to provide enough savings to meet the proposed energy levels. (Zero Zone, No. 75 at p. 4)

Hoshizaki added that technologies including fan controls, improved fan motors, improved glass doors, and occupancy sensors are already in use and therefore the ensuing review cannot be economically justified. (Hoshizaki, No. 76 at p. 3) SCC commented that "enhanced" coils are already in place and designed to reduce charge for A3 flammable refrigerants. (SCC, No. 74 at pp. 1–2) AHRI commented that technologies including the use of LED lighting, R-290 for self-contained units, and ECM evaporator fan motors are already in use. (AHRI, No. 81 at pp. 4–5) During the November 2023 Public Meeting, AHRI additionally stated that its members are already using adaptive defrost systems, increased insulation thickness, and improved evaporator coil design. (November 2023 Public Meeting Transcript, No. 64 at p. 19) NAFEM commented that CRE manufacturers already use most of the screened-in technologies listed in the October 2023 NOPR, including: insulation; lighting; improved transparent doors (low-emissivity coatings, inert gas, and additional panes); compressors (improved efficiency, alternative refrigerants, and variable-speed

<sup>67</sup> See section 5.7.2.8, Variable-Speed Condenser Fan Control, at [www.regulations.gov/document/EERE-2017-BT-STD-0009-0093](http://www.regulations.gov/document/EERE-2017-BT-STD-0009-0093) at pp. 5–60.

compressors); evaporators (increased surface area and evaporator coil design); condensers (increased surface area and tube and fin enhancements); fans (fan motors controls); and “other” (defrost systems and liquid suction heat exchangers). (NAFEM, No. 83 at p. 3)

NAFEM and NAMA requested that DOE revise the October 2023 NOPR and accompanying NOPR TSD to address NAFEM and NAMA’s comments. (NAFEM, No. 83 at p. 26; NAMA, No. 85 at pp. 19–20)

NAFEM commented that the proposed standards in the October 2023 NOPR would substantially increase manufacturing costs because many of the design options analyzed in the October 2023 NOPR are already in place, and other screened-in technologies have substantial shortcomings, leaving the CRE industry no other available and feasible technologies to meet the standards. (*Id.* at p. 18) Therefore, NAFEM commented that its members will turn to proposed technologies such as variable-speed compressors, which have shown promise in certain applications to reduce energy consumption but have not proven to be economically a viable option for many CRE within the timeline of this rulemaking. (*Id.*)

In response to commenters requesting DOE review the design options assumed in the baseline, DOE reviewed the design options identified in this final rule and determined that ECM evaporator and condenser fan motors in most equipment classes and LED lighting in all equipment classes are typically present in baseline units. Therefore, for the final rule analysis DOE assumed that ECM evaporator and condenser fan motors would be used in baseline equipment in most classes and LED lighting would be used in baseline equipment in all classes and thus could not be considered as energy-saving design options for those classes. DOE’s reverse-engineering showed that many units at baseline do not use the design options that the above commenters have claimed are already widely in use (*i.e.*, occupancy sensors, variable-speed compressors, and improved transparent doors). DOE has also observed a range of cabinet wall thicknesses in its reverse engineering analysis. Therefore, DOE has determined that the baseline assumptions in this final rule are representative of baseline CRE currently available in the market, and DOE disagrees that energy savings are being double counted in this final rule. See appendix 5A of the final rule TSD for a full list of baseline components analyzed for each equipment class.

AHRI resubmitted data collected from AHRI, NAFEM, and NAMA in response to the June 2022 Preliminary Analysis, which showed that data used for the analysis was outdated and did not align with current market conditions. (AHRI, No. 81 at pp. 3–4) NAFEM commented that many of the proposed technologies are widely used in VCS equipment. (NAFEM, No. 83 at p. 5) AHRI commented that, after reviewing the June 2022 Preliminary TSD, AHRI, NAFEM, and NAMA conducted a survey of members that manufacture CRE in an effort to share with DOE up-to-date information (“Trade Associations Survey”). (AHRI, No. 81 at p. 3) AHRI submitted survey results in an attachment to its comment detailing that the June 2022 Preliminary TSD design options include many that are currently in use to meet existing standards and others that raise concerns regarding applicability, as well as some design options that manufacturers could support. (*Id.*) AHRI commented that, according to the Trade Associations Survey, the efficiency levels proposed by DOE raise questions and concerns and there is uncertainty that implementing anticipated design options would result in energy efficiency improvements. (*Id.* at pp. 3–4)

Continental commented that the design options included in DOE’s analysis are not technically feasible and/or economically justified to achieve the proposed reductions in energy use for all product configurations within each covered equipment type in the October 2023 NOPR. (Continental, No. 86 at pp. 3–6) Continental commented that development of its new line of R–290 products required entire redesign of all cooling systems—including new compressors, evaporator coils, and condenser coils—along with new electrical components for compatibility with flammable refrigerants. (*Id.* at p. 3)

In response to the August 2024 NODA, NAMA commented that the NODA design options for VCT.SC.M, VOP.SC.M, and HZO.SC.L contain engineering solutions that have been part of the production of CRE products for more than 10 years. (NAMA, No. 112 at p. 4) NAMA commented also that DOE has double counted the energy savings from the design options in the baseline so the improvement in energy efficiency based on the August 2024 NODA and October 2023 NOPR are much greater than reality. (*Id.*)

DOE acknowledges that the Trade Associations Survey may indicate the use by some manufacturers of certain technologies proposed as design options in the October 2023 NOPR. However,

the survey results do not provide information regarding the efficiency levels achieved by the specific equipment using those technologies, so the results do not indicate which technologies are used at baseline and which technologies are used in equipment that exceed the baseline. For this reason, DOE cannot assume based on the survey results that all technologies mentioned are already in use at baseline. For the survey results to be useful for DOE’s analysis, the survey would need to provide information of the correlation of the design options with efficiency levels.

In response to the comment from Continental on technological feasibility, DOE notes that all technology options considered in this final rule were initially determined to pass the screening criteria, which includes technological feasibility. While not all technology options that pass the screening criteria are directly analyzed in this final rule, the technology options are all considered technologically feasible based on DOE’s screening criteria. In addition, DOE does not remove design options based on cost-effectiveness. Rather, DOE analyzes the cost-effectiveness through the cost-efficiency curves (presented in chapter 5 of the final rule TSD) and other analyses presented in section IV.F of this document.

In response to the October 2023 NOPR, DOE also received more extensive comments on specific design options analyzed in the October 2023 NOPR, including night curtains, variable-speed compressors, occupancy sensors, and door design changes. These comments are discussed in the following paragraphs.

### iii. Night Curtains

In the October 2023 NOPR and the August 2024 NODA,<sup>68</sup> DOE considered night curtains as a design option in its analyses. 88 FR 70196, 70224.

In response to the October 2023 NOPR, NAFEM commented that its members report substantial customer resistance to night curtains because of the difficulty for customers to access items behind the curtains, especially shoppers who are not using a basket or cart and are carrying multiple items. (NAFEM, No. 83 at pp. 6–7) Hussmann commented DOE’s assumption that night curtains and lighting controls will lead to new energy savings for VOP.RC.M and SVO.RC.M equipment classes is flawed. (Hussmann, No. 80 at pp. 5–6) Hussmann also stated that

<sup>68</sup> See [www.regulations.gov/document/EERE-2017-BT-STD-0007-0090](https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0090).



these equipment options have been available to order on Hussmann's merchandisers for nearly 20 years in the case of night curtains and 15 years for lighting controls, and if retailers are not ordering these options now, they do not want them and will not use them in their stores, even if they are automatically applied to the merchandisers they purchase. (*Id.*) Hillphoenix commented that it did not implement night curtains on CRE to meet the 2017 energy requirements and it has reduced energy consumption using other technology design options. (Hillphoenix, No. 77 at p. 5) Hillphoenix also stated that night curtains should not be considered a preferred option to achieve lower energy consumption. (*Id.*)

In response to the comment from NAFEM, DOE notes that the CRE test procedure accounts for 6 hours of night curtain use per 24-hour period, and, in this final rule, DOE analyzes energy savings based on the DOE test procedure. DOE assumes that night curtains would not be in use when customers are in the store, and therefore, they would not need to access items behind the curtain as described in NAFEM's comment.

In response to the comment from Hillphoenix, DOE notes that if night curtains were not implemented to meet the 2017 energy conservation standards, then it is appropriate for DOE to consider this design option as a potential pathway to decrease energy use.

In response to the comment from Hussmann, DOE notes that, as stated by Hillphoenix, not all manufacturers have implemented this design option (other than as an optional feature), and it is therefore still appropriate to consider as a design option to improve efficiency.

In response to the August 2024 NODA, Zero Zone commented that the majority of grocers do not specify night curtains, and that the life span is only 1–3 years, making pay back on energy savings unlikely. (Zero Zone, No. 114 at p. 2)

Hillphoenix commented that while night curtains promote energy reduction, they also negatively impact the refrigeration system by causing short cycling of the compressor, refrigerant oil logging, or in the worst case, liquid slugging of the compressor. (Hillphoenix, No. 110 at p. 10) Hillphoenix commented that this increases stress on start components of fixed speed compressor units on self-contained models. (*Id.*)

DOE responds that neither the October 2023 NOPR nor the August 2024 NODA comments provide clear

justification for screening out night curtains. Specifically, Hussmann indicates that they have been available for use for 20 years, despite potential for short cycling. Although Hussmann claims that savings estimates are flawed, they have not provided explanation or data that would allow DOE to adjust its analysis of night curtain savings. DOE notes that, in response to Zero Zone's comment regarding night curtain life span, the life-cycle cost and payback period analysis has considered replacement costs for night curtains prior to the equipment end of life, see section IV.F.5 of this document for details.

#### iv. Variable-Speed Compressors

In the October 2023 NOPR, DOE used performance data for variable-speed R–290 compressors currently available on the market in DOE's engineering spreadsheet to estimate the performance impacts of transitioning to a variable-speed compressor. 88 FR 70196, 70219. DOE assumed that variable-speed compressors would operate at the minimum speed under steady-state operation, and also assumed that the fan motors would operate during the compressor run time (*i.e.*, the fan motor operating duration would likely increase compared to a single-speed compressor). *Id.* Overall, DOE estimated a 0.5–25 percent energy consumption reduction when implementing variable-speed compressors, with savings varying depending on equipment class. *Id.*

In response to the October 2023 NOPR, Zero Zone stated that DOE makes a very specific assumption on the energy efficiency gains of a variable-speed motor, but according to its supplier, it is very difficult to predict the efficiency gains of a variable-speed motor. (Zero Zone, No. 75 at p. 4) Zero Zone added that the improvement depends on the duty cycle of the compressor, which depends on the size of the fixed-speed compressor compared to the size of the variable-speed compressor. (*Id.*) Zero Zone commented that it doubts the efficiency gains listed by DOE, and Zero Zone requested that DOE remove variable-speed motors from the analysis until data can be gathered and reviewed. (*Id.*)

NAMA stated that a change to a VSC would not save 13.4 percent of the baseline. (NAMA, No. 85 at pp. 11–12) NAMA added that variable-speed compressors would save 0.1 kWh/day, in comparison to DOE's estimate of 0.625 kWh/day for the VCT.SC.M equipment class. (*Id.* at p. 14) NAMA further stated that for many models of smaller bottle coolers (< 30 ft<sup>3</sup>), these

variable-speed compressor motors are not available for units using R–290 refrigerant. (*Id.* at p. 23) NAMA added that the October 2023 NOPR energy savings of 0.625 kWh/day is five times more savings than NAMA has seen in its experiments with variable-speed compressors. (*Id.*) NAMA stated that this may be the improvement of the part in a bench test, but this is not the result in the actual unit tested to the DOE test procedure. (*Id.*) NAMA stated also a discrepancy between the VSC energy savings found in the June 2022 Preliminary Analysis and the October 2023 NOPR. (*Id.*)

Hoshizaki commented that VSCs will require design controls to perfect the cycles for optimum energy use, adding time for staff to prepare the compressors and fans for the control features to make sure each unit has its own controls based on the defrost and run time. (Hoshizaki, No. 76 at p. 5) Hoshizaki commented that VSCs and fan motor lifetimes may be less than current components. (*Id.*) Hoshizaki stated that the warranties for VSCs may be closer to 3–5 years compared to the 5–7-year warranties for compressors that is currently common in the market, due to increased repairs if manufacturers are forced to transition to VSCs without adequate time for full-life testing at many ambient and humidity conditions. (*Id.*) Hoshizaki added that, if the defrost settings are incorrect, freeze-ups may occur due to true-to-life door-opening conditions. (*Id.*)

Hillphoenix commented that VSC technology can have an approximately 15-percent minimum efficiency improvement to the overall CRE product's energy due to fewer starts and stops and continuous compressor speed control to match the load requirement. (Hillphoenix, No. 77 at p. 8) Hillphoenix commented that Copeland reported that the variable-speed compressor motor itself only adds approximately 5 percent efficiency gain due to compressor motor enhancements, whereas the calculated compressor energy reduction from DOE's engineering spreadsheet shows a 44.9-percent energy savings when comparing an R–290 reciprocating with an R–290 variable-speed compressor. (*Id.*) Hillphoenix stated that the energy values DOE used to represent the impact of changing refrigerants to R–290 with VSCs are broad assumptions and are not reflective of actual tested values. (*Id.*) Hillphoenix commented that to estimate the performance impacts of transitioning to a variable-speed compressor, DOE should use values established by testing physical units. (*Id.*)

In support of the August 2024 NODA, DOE reviewed variable-speed compressors on the market at the time of the analysis, updated its database of variable-speed compressor performance, and updated its variable-speed compressor analysis. 89 FR 68788, 68793

Specifically, DOE observed that some manufacturers have updated their VSC coefficients since publication of the October 2023 NOPR. Due to these updates, and to maintain a methodology consistent with that used for single-speed compressors, DOE has updated results in this final rule based on the average efficiency of the market for variable-speed compressors if three or more compressor brands have available variable-speed compressors at the appropriate capacity, and selecting the lower-efficiency compressor if only two compressor brands are available at a specific cooling capacity. DOE also adjusted the calculation for the evaporator and condenser temperatures when operating at part load using variable-speed compressors. DOE used in the analysis an evaporator temperature 3 °F higher than for single-speed compressor operation, and a condenser temperature 5 °F lower to represent the benefit of operation at part load. This simplified the analysis as compared to the approach taken in the October 2023 NOPR, in which DOE based the evaporator and condenser temperature differences on a logarithmic mean temperature difference (“LMTD”) calculation that was adjusted based on the change in duty cycle when switching from single-speed to variable-speed compressors.<sup>69</sup> Based on these updates, in the August 2024 NODA analysis, DOE estimated that the energy consumption reduction from implementing variable-speed R-290 compressors would range from approximately 2.5 to 19.2 percent, depending on the equipment class and the representative capacity. Comparatively, in the October 2023 NOPR, DOE estimated approximately 0.5 to 25 percent energy consumption reduction when implementing variable-speed R-290 compressors.<sup>70</sup> In the March 2014 Final Rule, precedent was established for an update to the analysis approach for compressors, where DOE updated the single-speed compressor assumptions in response to commenter feedback on the NOPR. See 79 FR 17725, 17760. For further details of the

calculations, see the August 2024 NODA engineering spreadsheet.<sup>71</sup> DOE notes that its updated approach provides a conservative estimate of energy use reduction associated with conversion to variable-speed R-290 compressors, due to use of the average or lower performance levels of available compressor models, and no consideration of potential additional savings associated with fan speed reductions.

In addition to updating the variable-speed compressor performance analysis, DOE updated the baseline assumption costs to include electronic controls at the baseline for all equipment classes in response to commenter feedback and based on observation of the CRE units torn down by DOE. While there would be development costs to program controls for variable-speed operation, there would be insignificant control hardware costs (other than the compressor motor inverter, which was included in the cost analysis), since baseline models would already have electronic controls. DOE notes that the development costs to optimize variable-speed compressors are accounted for the MIA, see section IV.J.2.c of this document for additional details on DOE’s conversion cost methodology and section V.B.2.a of this document for the estimated conversion costs at each analyzed TSL. See section IV.F.5 for discussion on maintenance and repair costs.

In response to the comment from Hillphoenix, DOE reiterates that DOE estimated that the range of energy use reduction associated with implementing variable-speed compressors was between approximately 0.5 and 25 percent in the October 2023 NOPR. This was reduced to a range of up to 19.2 percent in the August 2024 NODA analysis. DOE is not aware of any equipment class where the October 2023 NOPR engineering spreadsheet showed a 44.9 percent reduction in energy use attributed to implementing variable-speed R-290 compressors.

In response to the August 2024 NODA, Continental continued to oppose the inclusion of VSCs as a design option to be incorporated over the next 3 years given their complexity and increased costs. (Continental, No. 107 at pp. 2–3) Continental argued that VSCs are currently only used in specialty configurations, and more time is needed to determine long-term savings as well as train staff on repairs. (*Id.*) Continental commented that they have extended product warranties in recent years,

covering parts and service for 5, 6 or 7 years from first use, which presents exposure to any risks from premature introduction of new features or components that have not been fully vetted. (Continental, No. 107 at p. 3)

In response, DOE notes that it is adopting a 4-year compliance period in this final rule, which provides an additional year for manufacturers to redesign CRE models to meet new and amended standards as compared to the October 2023 NOPR. Additionally, DOE notes that it considers the development costs associated with implementing variable-speed technology in its MIA (see section IV.J.2.c of this document for additional information on DOE’s conversion cost methodology). See section IV.F.5 for discussion on maintenance and repair costs.

Hillphoenix commented that they agree with the temperature reduction values when applying variable-speed compressors, but does not agree with the max energy reduction of 19.2 percent, and stated that test data from the VCS.SC.L class reflects approximately 13 percent max energy savings. (Hillphoenix, No. 110 at p. 4.) Since variable speed compressor technology is new, test data is not available for VCS.SC.M models, but based on industry knowledge Hillphoenix estimated the savings will be similar to the low temperature class. (*Id.* at pp. 4–5)

DOE notes that 19.2 percent energy use reduction associated with the variable-speed compressor design option is the maximum energy savings of all the analyzed classes and that for the VCS.SC.L and VCS.SC.M classes, the analyzed energy savings are 15.7 percent and 10.6 percent, respectively, which aligns well with Hillphoenix’s statement of expectations for the VCS.SC.L and VCS.SC.M classes.

Delfield commented they have tested their own units and found that the energy consumption of CRE with a variable-speed compressor compared to a well-designed system with a fixed-speed compressor is essentially the same because the efficiency gained by using a variable-speed compressor is offset by increased runtime of fans and heaters. (Delfield, No. 99 at p. 2) Delfield further commented that the cost of a variable-speed compressor and the required inverter is double the cost of an efficient fixed-speed compressor. (*Id.*) Delfield requested that DOE remove this technology from the analysis. (*Id.*)

In response, DOE notes that its analysis for variable-speed technology did consider increased run time of fans, but did not consider additional improvement that could be achieved

<sup>69</sup> See the calculations tab of the engineering spreadsheet at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0055](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0055).

<sup>70</sup> See section 5.5.3.1 of the October 2023 NOPR TSD at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0051](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0051).

<sup>71</sup> See [www.regulations.gov/document/EERE-2017-BT-STD-0007-0091](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0091).



through the use of fan speed reduction during compressor part-load operation. Further, Delfield's mention of heater runtime increase suggests that they control the antisweat heaters to run when the compressor is energized and did not adjust antisweat heater wattage during variable-speed compressor testing to arrive at the same heater runtime and therefore the same antisweat heater energy use as without a variable-speed compressor. Since a variable-speed compressor runs longer than a single-speed compressor, if Delfield's antisweat heater is energized whenever the compressor is energized then it runs longer than it would otherwise with a single-speed compressor. Therefore, Delfield claims its testing using a variable-speed compressor shows little difference in energy use despite the energy savings from the variable-speed compressor because the antisweat heater was not adjusted to have the same runtime and energy use as without a variable-speed compressor. It is not clear why heater energy use should be increased for a variable-speed compressor, so it is not clear that their testing represents an optimized variable-speed system. DOE notes that Delfield's statement regarding variable-speed compressor costs are consistent with DOE's estimates. DOE concludes that insufficient evidence has been provided to justify removing variable speed compressor technology from the analysis.

#### v. Occupancy Sensors

In response to the October 2023 NOPR, Zero Zone, Hussmann, and NAFEM commented that occupancy sensors have been available for purchase and use for more than 10 years and were initially used by customers. (Zero Zone, No. 75 at p. 4; Hussmann, No. 80 at pp. 5–6; NAFEM, No. 83 at p. 6) However, Zero Zone, Hussmann, NAFEM, Hillphoenix, and NAMA commented that food retail establishments have stopped purchasing occupancy sensors on units or they turn off the motion sensors because their customers may think the unit is malfunctioning, which has a negative impact on sales and the utility of the unit. (Zero Zone, No. 75 at p. 4; Hussmann, No. 80 at pp. 5–6; NAFEM, No. 83 at p. 6; Hillphoenix, No. 77 at p. 6; NAMA, No. 85 at p. 24) NAMA also stated that occupancy sensors are more expensive and do not save as much energy as analyzed in the October 2023 NOPR and that with newer LED lighting technology available, occupancy sensors may become outdated. (NAMA, No. 85 at pp. 12, 24) Hussmann added that if a store is closed during nighttime hours, it is a

widely used practice to separately wire all the display case lighting to dedicated electrical circuits that can be turned off on a fixed schedule, which is a more cost-effective way of saving lighting energy than individual lighting controllers on each display case. (Hussmann, No. 80 at p. 5)

In response to the August 2024 NODA, Zero Zone commented that the majority of their customers do not request motion sensors, and some removed it from their specifications, as having lights off indicates to customers that the case is broken. (Zero Zone, No. 114 at p. 2) Continental disagreed with DOE's statement that 75 percent of products would benefit from the use of occupancy sensors, and argued that this is not a viable feature due to misapplication which would result in service issues, and requested the removal of the design option. (Continental, No. 107 at p. 2)

ASAP *et al.* commented that while they understand the reduced savings from the occupancy sensors, they state that manufacturers will be able to utilize occupancy sensors to meet any amended standards. (ASAP *et al.*, No. 106 at p. 3) ASAP *et al.* added that CRE test procedure does not include any comparable assumption about deactivation (*i.e.*, the test procedure gives full credit to occupancy sensors). (*Id.*)

In response to comments about occupancy sensors either not being desired by certain end users, or certain end users using their own on-site control system, DOE has revised the energy use analysis for occupancy sensors to consider that they would not be used by all end-use customers. Specifically, the revised energy use analysis assumes only 75 percent of end users would use occupancy sensors, as discussed in section IV.E of this document. However, although DOE has considered partial non-use of occupancy sensors in the energy use analysis, it has not revised the engineering assumptions related to the occupancy sensors in this final rule because the engineering analysis is based on the DOE test procedure, which does not consider potential non-use of the technology. The DOE test procedure is not intended to anticipate how end users may modify the unit in the field, including deactivation of occupancy sensors. Further, DOE did not revise its MPCs for occupancy sensors, as suggested by NAMA, because DOE did not receive any data from commenters to suggest an alternative MPC would be more representative. Also, DOE notes that it does not expect manufacturers would need to incorporate occupancy sensors

with dimming capability to meet the adopted TSL (*i.e.*, TSL 3).

#### vi. Door Design Changes

In response to the October 2023 NOPR, Hillphoenix commented that vacuum-insulated glass ("VIG") is not applicable for low-temperature applications due to the glass bending in the extreme temperature difference. (Hillphoenix, No. 77 at p. 7) Hillphoenix commented that, more importantly, all suppliers of VIG stopped production for CRE products due to the low demand and refused to supply the market. (*Id.*) Hillphoenix stated that DOE referenced information in the October 2023 NOPR TSD that is no longer valid and that Anthony International discontinued VIG in 2019.<sup>72</sup> (*Id.*)

NAMA expressed concern with the safety hazard presented by the additional weight from increased panes in doors together with noble gas insulation, which could make the product excessively top heavy. (NAMA, No. 85 at pp. 24–25) NAMA further commented that the June 2022 Preliminary Analysis results for door design options are no longer relevant. (*Id.* at p. 25)

SCC commented that VIG would eliminate any curved glass models as this technology simply does not exist except in flat structural glass. (SCC, No. 74 at p. 2) SCC commented that, on SOC models, the glass is lifted and held by gas cylinders for ease of loading product, not a swing door like VCT units, and the extra weight and constant opening would severely degrade the reliability of the equipment and may constitute a safety issue for merchandisers. (*Id.*)

Hillphoenix commented that medium-temperature doors are currently manufactured with double-pane glass that is filled with argon gas and low-temperature doors are currently manufactured with triple-pane glass that is filled with argon gas. (Hillphoenix, No. 77, p. 6) Hillphoenix stated that the cost of krypton gas is more than double the cost of argon gas and there is a limited supply of krypton gas available to the market. (*Id.*) Hillphoenix commented that triple-pane glass on medium-temperature CRE would increase cost for a minimal efficiency gain. (*Id.* at p. 7)

In response to the comments regarding increased cost, DOE does not screen out a technology based on its cost-effectiveness. In response to

<sup>72</sup> See [www.buildinggreen.com/product-review/saving-energy-supermarkets-vacuum-insulated-glass](https://www.buildinggreen.com/product-review/saving-energy-supermarkets-vacuum-insulated-glass).

comments about weight concerns, DOE notes that low-temperature freezers already primarily use triple-pane glass packs, which demonstrates the ability of CRE to use this technology. In response to comments with concerns about VIG supply and application in low-temperature applications, DOE notes that there are examples of manufacturers that continue to offer VIG doors on commercial freezers.<sup>73</sup> And in response to comments regarding the cost of krypton gas, DOE has revised its MPC for this design option based on commenter feedback. As discussed in section V.C.1 of this document, DOE does not expect manufacturers would need to implement VIG doors or triple-pane glass doors with krypton fill to meet the adopted TSL. In response to the comment from SCC about VIG not being suitable for curved glass, DOE notes that the analyzed SOC classes in this final rule only considered multiple-glass-layer or VIG design options for the flat glass rear doors and not the non-door glass area. Furthermore, it is DOE's understanding that the upward-lifting front glass mentioned by SCC for SOC models can be curved, but because DOE's analysis does not consider an increase in glass layers for the non-door

glass area, SCC's comment about the impact on durability of the gas cylinders used to support the curved glass when open is not relevant. Also, DOE notes that it does not expect manufacturers would need to incorporate vacuum-insulated glass doors to meet the adopted TSL (*i.e.*, TSL 3).

NAMA commented that the savings from increased door panes together with noble gas insulation are more likely to be 0.3–0.6 kWh/day, rather than the projected 1.270 kWh/day. (NAMA, No. 85 at p. 25)

In response to the comment from NAMA, it appears that NAMA is referencing the VCT.SC.M results provided in the June 2022 Preliminary Analysis, for which the “high performance door” design option for VCT.SC.M saved 1.270 kWh/day compared to the previous design option step;<sup>74</sup> however, section 5.8 of the October 2023 NOPR TSD presents savings based on the revised analysis, which result in less than 0.1 kWh/day of savings. Therefore, DOE has revised the analysis addressed by NAMA's comment in the August 2024 NODA and in this final rule, resulting in comparable results to NAMA's comment.

#### c. Equipment Classes With Unique Energy Use Characteristics

In the October 2023 NOPR, DOE proposed additional energy use allowances for certain equipment classes having unique features. DOE also proposed definitions to clarify which features are eligible (see section IV.A.1.b for more description regarding the definitions). 88 FR 70196, 70230–70231. DOE determined potential energy use allowances for these features based on CCD data, information from commenters, and manufacturer interviews, and DOE's directly analyzed units showing an energy use difference between certain types of CRE. *Id.* at 88 FR 70230. As proposed in the October 2023 NOPR, these equipment have the specified performance-related features and different maximum energy use to represent separate additional equipment classes.

In the October 2023 NOPR, DOE tentatively developed multipliers for pass-through, sliding, roll-in doors, and roll-through features. *Id.* at 88 FR 70231. See table IV.13 for additional details on what was proposed in the October 2023 NOPR.

**Table IV.13 Description of Equipment Class Multipliers for Unique Door Characteristics in the October 2023 NOPR**

Door Type	Applicable Equipment Classes	Equipment Type Coefficient	Equipment Class Multiplier
Pass-through	VCT.RC.M; VCT.SC.M; VCT.SC.L.; VCS.SC.M; VCS.SC.L	PT	1.04
Sliding	VCT.RC.M; VCT.SC.M	SD	1.07
Pass-through and Sliding	VCT.RC.M; VCT.SC.M	SDPT	1.11
Roll-in	VCT.RC.M; VCT.SC.M.; VCS.SC.M; VCS.SC.L	RI	1.05
Roll-through	VCT.RC.M; VCT.SC.M.; VCS.SC.M; VCS.SC.L	RT	1.09

In the October 2023 NOPR, DOE additionally tentatively developed multipliers for forced-air evaporators.

*Id.* at 88 FR 70212. Based on CCD data, information from commenters and manufacturer interviews, and DOE's

directly analyzed units showing an energy use difference between certain types of CRE, DOE tentatively

<sup>73</sup> See [valprorefrigeration.com/glass-door-merchandisers/glass-door-freezer-merchandisers/](https://valprorefrigeration.com/glass-door-merchandisers/glass-door-freezer-merchandisers/)

*two-swing-glass-door-merchandise-freezer-vp2f-48hcl*.

<sup>74</sup> See chapter 5, section 5.8 of the June 2022 Preliminary TSD at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0013](https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0013).



developed an energy use multiplier for equipment classes that were directly analyzed in the October 2023 NOPR as CRE with a cold-wall evaporator and for which DOE observed models with

forced-air evaporators in those equipment classes on the market. *Id.* at 88 FR 70231. DOE tentatively developed this multiplier to account for the additional energy use associated with a

forced-air evaporator as compared to a cold-wall evaporator. *Id.* See table IV.14 for additional details of what was proposed in the October 2023 NOPR.

**Table IV.14 Description of Equipment Class Multipliers for Unique Refrigeration Systems in the October 2023 NOPR**

Refrigeration System	Applicable Equipment Classes	Equipment Type Coefficient	Equipment Class Multiplier
Forced Air	HCS.SC.L	FA	1.2

In response to the October 2023 NOPR, SCC and AHRI commented that they appreciate that DOE is applying the definitions to VCT and VCS equipment classes to allow for more energy for rear-door options. (SCC, No. 74, p. 3; AHRI, No. 81 at pp. 5–6) Due North supported DOE's proposal to separate out the newly introduced VCT.SC.M.PT and VCT.SC.M.SDPT classes from the VCT.SC.M class to address their construction uniqueness and the related increased energy use. (Due North, No. 87 at p. 2)

ITW, the CA IOUs, and Continental supported DOE's proposal to add provisions for non-traditional door designs including sliding, rolling, and pass-through doors; Continental expressed support for the provisions proposed for horizontal closed low-temperature models with forced air evaporators. (ITW, No. 82 at p. 6; CA IOUs, No. 84 at p. 1; Continental, No. 86 at p. 2) Continental commented that these equipment types have differentiating characteristics that impact energy consumption. (Continental, No. 86 at p. 2) The CA IOUs commented that creating separate standards for these designs acknowledges the energy impact of non-traditional door designs on specialty refrigeration equipment. (CA IOUs, No. 84 at p. 1)

SCC, AHRI, Hoshizaki, and Hussmann agreed in principle to the use of an energy use multiplier for certain equipment classes but stated DOE has not allowed enough time for manufacturers to test and validate the multipliers. (SCC, No. 74 at p. 4; AHRI, No. 81 at p. 8; Hoshizaki, No. 76 at p. 3; Hussmann, No. 80 at p. 6) AHRI and Hussmann commented that they require 1 year of testing, and Hoshizaki requested time in the first quarter of 2024 to access its test room and validate the numbers in the October 2023 NOPR. (AHRI, No. 81 at p. 8; Hussmann, No. 80 at p. 6; Hoshizaki, No. 76 at p. 3) ITW also commented that it would like to conduct laboratory evaluations of the

new equipment categories and provide DOE with test data to validate the differences in performance for these new categories. (ITW, No. 82 at p. 6) SCC and NEEA and NWPCC commented that they would like to see the data and analysis around how the energy use multipliers have been developed. (SCC, No. 74 at p. 4; NEEA and NWPCC, No. 89 at p. 1) NEEA and NWPCC stated that while they understand DOE's intent for the energy use multipliers, DOE's explanation for how the energy use multipliers were developed is not clear. (NEEA and NWPCC, No. 89 at p. 2) NEEA and NWPCC added that stakeholders cannot provide comment on whether the multipliers are too conservative or too aggressive without knowing what information or data the multipliers are based on and expressed concern that these multipliers are creating an insufficiently justified loophole for less efficient equipment to be manufactured. (*Id.* at p. 2) NAMA commented that it does not understand the concept of using a "multiplier" within the CRE rulemaking and the information given in the October 2023 NOPR does not contain enough information for NAMA members to comment on. (NAMA, No. 85 at p. 30)

NEEA and NWPCC stated that ENERGY STAR currently certifies sliding, roll-in, and pass-through units that meet the energy use requirements of their respective equipment classes, which would indicate that there may be no need for an energy multiplier solely based on these door types, as equipment already exists that meets a higher efficiency threshold than DOE's current standard without a separate threshold from their single-door counterparts. (NEEA and NWPCC, No. 89 at p. 2)

Delfield commented that the suggested allowances for most categories of specialty cabinets are not reasonable and that any additional allowances should consider the refrigerated volume of the cabinet rather than a fixed number, as proposed in some of the categories. (Delfield, No. 71

at p. 1) Delfield recommended that DOE implement a 20-percent allowance for pass-throughs, sliding doors, and roll-ins used in VCS.SC.M, VCS.SC.L, VCT.SC.M, and VCT.SC.L equipment classes, as well as an additional 20 percent for roll-throughs and also for pass-throughs with sliding doors. (*Id.*) Delfield added that these low-volume, specialty cabinets have very little impact on national energy consumption and the environment. (*Id.*)

ITW recommended that DOE create an additional category for cabinets with drawers and Delfield recommended an additional category specifically for freezers with drawers. (ITW, No. 82 at pp. 2, 4; Delfield, No. 71 at p. 2) Delfield commented that freezer drawers require additional heater wires and gaskets, which contribute to increased energy consumption and suggested a 20-percent additional allowance for freezers with drawers to be classified as VCS.SC.L.DRW. (Delfield, No. 71 at p. 2) ITW commented that its test data shows that the energy use is measurably greater in equipment with drawers versus equipment with doors, thus meriting DOE's creation of a separate category for this type of equipment. (ITW, No. 82 at p. 2) ITW commented that it had conducted testing on the same cabinet with both drawer and door configuration, and test results showed that there is a 27-percent higher energy consumption on the drawer freezer compared to same-size door freezer. (*Id.* at p. 4)

In the August 2024 NODA, DOE presented revised analysis results for a range of potential efficiency levels. 89 FR 68788. 68802–68825. As part the August 2024 NODA, DOE applied a simplified multiplier approach to the eligible equipment classes discussed in the October 2023 NOPR, evaluating the use of a single multiplier for all evaluated equipment classes and feature groupings, including pass-through, sliding door, sliding-door pass-through, roll-in, roll-through, forced-air evaporator, and drawers. *Id.* at 89 FR





and this final rule include units with

drawers in the list of qualifying features.  
*Id.* at 89 FR 68793, 68795

**Table IV.15 Applicable Features for Equipment Class Standards Designated with Feature**

Equipment Class	Applicable Feature(s)
VCT.SC.M (≤ 100)	Pass-through doors Sliding doors Both pass-through and sliding doors Roll-in doors Roll-through doors
VCT.SC.L (≤ 70)	Pass-through doors
VCS.SC.M	Pass-through doors Roll-in doors Roll-through doors Drawers
VCS.SC.L (≤ 100)	Pass-through doors Roll-in doors Roll-through doors Drawers
HCS.SC.L	Forced air evaporator

DOE notes that EPCA, as codified, contains what is known as an “anti-backsliding” provision, which prevents the Secretary from prescribing any amended standard that either increases the maximum allowable energy use or decreases the minimum required energy efficiency of a covered product. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(1)) Therefore, any equipment classes with features in this final rule may be limited or adjusted due to the anti-backsliding provision. In this final rule, the energy use of the selected efficiency level in TSL 3 is adjusted accordingly, if needed, to avoid backsliding against the current standard.

Due North commented that the proposed conservation standards in the October 2023 NOPR do not provide an energy use allowance for smart technology accessories, such as connectivity devices for remote control and monitoring; inventory management smart shelves, image recognition

cameras, and associated computers; pay terminals; and similar technology-based accessories. (Due North, No. 87 at p. 2) Due North added that the advent of smart technologies, including artificial intelligence, will result in rapidly growing demand for these types of accessories, and DOE energy conservation standards may serve as obstacles for new technologies and innovation. (*Id.*)

In response to the comment from Due North regarding smart technologies, DOE did not propose an energy use allowance for smart technology accessories in the October 2023 NOPR. DOE notes that neither Due North, nor any other commenter, has provided data on the energy use of these technologies for CRE currently available on the market. Therefore, in this final rule, DOE is not including an energy use allowance for smart technologies. DOE welcomes any data stakeholders can provide on the energy use and adoption

of these technologies in CRE for consideration in any potential future rulemaking.

Supporting Data

DOE found drawer units in CCD and compared them to analogous units with doors to analyze the increase in daily energy consumption associated with drawer units, taking into account volume differences. Characteristics shared between the pairs of analogous units include manufacturer, basic model line, and approximate dimensions. Differences in rated refrigerated volume were normalized by dividing the rated energy consumption of each unit by the rated volume, using that value to compare units in a pair with each other. The CCD data used for this analysis is compiled in table IV.16, and the average of these results is 9.9 percent increase in energy use, corresponding to a multiplier of 1.099.

**Table IV.16 CCD Unit Comparisons for Unique Physical and Functional Attributes**

Unit	Equipment Class	Unique Attribute Code	Rated Daily Energy Consumption (kWh/day)	Rated Volume (ft <sup>3</sup> )
Drawer 1	VCS.SC.L	D	2.93	9
Door 1	VCS.SC.L	D	2.16	7.14
Drawer 2	VCS.SC.L	D	2.65	6.4
Door 2	VCS.SC.L	D	2.67	6.5
Drawer 3	VCS.SC.L	D	2.79	7.07
Door 3	VCS.SC.L	D	2.22	7.07
Drawer 4	VCS.SC.L	D	1.35	4.26
Door 4	VCS.SC.L	D	1.39	4.7
Drawer 5	VCS.SC.M	D	31.34	2.19
Door 5	VCS.SC.M	D	31.34	2.04
Drawer 6	VCS.SC.M	D	20.41	1.61
Door 6	VCS.SC.M	D	20.41	1.67
Drawer 7	VCS.SC.M	D	16.94	1.95
Door 7	VCS.SC.M	D	16.94	1.98
Drawer 8	VCS.SC.M	D	13.28	1.6
Door 8	VCS.SC.M	D	13.35	1.12
Drawer 9	VCS.SC.M	D	7.97	1.67
Door 9	VCS.SC.M	D	8.61	1.7
Drawer 10	VCS.SC.M	D	6.79	1.61
Door 10	VCS.SC.M	D	7.35	1.64

## d. DOE Test Data

In response to the October 2023 NOPR, AHRI commented it did not find any specific information on when DOE tested products or conducted physical teardowns specific to the October 2023 NOPR. (AHRI No. 81 at p. 10) AHRI listed the sections that include discussion of the “teardown analysis,” which include 2.4.2 Cost Analysis, 5.1 Introduction, 5.6 Core Case Costs, and Energy Consumption Model. (*Id.*) AHRI, NAMA, NAFEM, SCC, and Hoshizaki requested that DOE make data related to CRE units tested and torn down for this rulemaking available, while maintaining manufacturer confidentiality, as concerns have been raised about the age of the units. (AHRI, No. 65 at pp. 1–2; NAMA, No. 85 at p. 7; NAFEM, No. 83 at pp. 8–9; Hoshizaki, No. 76 at p. 3; SCC, No. 74 at p. 2) AHRI and NAFEM expressed concern that DOE may be using units in the CRE teardowns that fail to align with those currently on the market, as significant changes were made with the energy conservation standards that went into effect in 2017. (AHRI, No. 65 at p. 2; NAFEM, No. 83 at pp. 8–9) AHRI and NAFEM added that changes in refrigerants have also taken place, such as the switch from R-134a and R-404A to low-GWP R-290 in

self-contained equipment. (AHRI, No. 65 at p. 2; NAFEM, No. 83 at p. 9)

AHRI requested that DOE add to the docket all documents and data referenced in the October 2023 CRE NOPR for stakeholder review and input; AHRI further requested that DOE add an additional 60 days to the public comment period for stakeholders to have adequate time to review the data and provide meaningful comments. (AHRI, No. 65 at pp. 1–2) AHRI added that DOE has failed to make available to interested parties all data it relied upon for calculations and conclusions in this rulemaking, as required by the Administrative Procedure Act (“APA”). (AHRI, No. 81 at p. 4) AHRI commented that DOE’s failure to provide the technical materials and analysis for its calculations does not align with precedence from the courts<sup>76</sup> on this issue. (*Id.*)

NAMA commented in support of these comments made by AHRI. (NAMA, No. 85 at pp. 9–10). NAMA added that several instances in the October 2023 NOPR do not appear to present the data DOE utilized to arrive at the provided conclusions and that

<sup>76</sup> AHRI specifically referenced *American Public Gas Association v U.S. Department of Energy*, 72 F. 4th 124, July 7, 2023.

this is a violation of the U.S. Court of Appeal for the District of Columbia’s statement that an agency is required to allow the public to review and analyze any technical materials that it relies upon in a proposed rule. (*Id.* at p. 9)

NAMA commented it was concerned that DOE had tested units using a computer rather than actual units and requested that DOE provide detailed information on the analysis. (*Id.* at p. 8)

Zero Zone stated that DOE’s description of how baseline levels are established in the October 2023 NOPR does not indicate that equipment was tested, and that baselines were established solely using data from the CCD. (Zero Zone, No. 75 at p. 1) Zero Zone questioned how DOE determined the efficiency increase of the technology options proposed without testing. (*Id.*) Zero Zone commented that if testing was not completed, DOE should reevaluate the assumptions for design options. (*Id.*) Zero Zone stated that competitors in the database already employ most of the design features proposed by DOE, and Zero Zone asked for additional detail on how DOE determined the energy reduction of the design options if no testing was performed. (*Id.* at p. 5)

NAMA stated that, to the industry, the fact that many of the efficiency options



have already been in use for years serves as additional proof that the teardowns, analysis, and reverse engineering were performed on machines that were not representative of today's production and did not follow the final test procedure for CRE. (NAMA, No. 85 at p. 5)

Hoshizaki commented that, if given the opportunity, it could accurately guide DOE on which Hoshizaki models were manufactured before and after the 2017 rulemaking based on model numbers. (Hoshizaki, No. 76 at p. 3) Hoshizaki commented that if DOE included units produced before the 2017 rulemaking, this would explain why many of the design factors mentioned in the October 2023 TSD were not identified as already in use. (*Id.*)

In response to the August 2024 NODA, AHRI commented that DOE had not made available the data that it relied upon in the NOPR, and continues to request DOE provide access to all information, technical studies, and data that it used for this commercial refrigeration equipment rulemaking. (AHRI, No. 104 at p. 6) AHRI commented that the Administrative Procedure Act and recent case law requires that all information used be publicly available. (*Id.*)

NAMA commented that DOE stated in the November 2023 public hearing that they would make available more information on the tear-down and testing of units, however, the NODA does not contain any new information on this. NAMA commented that all of the testing was done on older machines: VCT.SC.M units were purchased in 2020 with R-290 refrigerant, VOP.SC.M unit was purchased in 2019 at 13 cu ft with R-404A refrigerant, no HZO.SC.L units were purchased or tested. (NAMA, No. 112 at p. 5)

Zero Zone commented that DOEs provided list of tear down equipment points to years of standards development that was not based on actual test data, and that DOE should have tested remote equipment. (Zero Zone, No. 114 at p. 1) Zero Zone requested that DOE postpone release of the rule until it has tested a more representative group of equipment. (*Id.*) Zero Zone stated that the standards are set at the average energy value, however manufacturers must develop equipment that has an average energy consumption below the standard so all the equipment found in a normal distribution of

manufacturing would meet the standard. Zero Zone suggests that DOE should increase the allowed energy by 3 standard deviations. (*Id.*)

NAFEM commented that there was new information analyzed in the August 2024 NODA, for which the data had not been shared publicly. (NAFEM, No. 101 at pp. 4–5) NAFEM stated that this includes specifically the update of R-290 compressor performance to reflect that of the database of CRE compressors, as well as that DOE conducted additional teardown tests to reduce the R-value from 8 to 6.5 per inch, baseline fan motor assumptions and use of electronic controls. (*Id.* at p.5)

NAFEM additionally referenced the comment from AHRI in response to the October 2023 NOPR which requested DOE's teardown information, which has not been provided. (NAFEM, No. 101 at p. 5) NAFEM stated that this contravenes well settled law and provided the examples of the decisions in *Am. Pub. Gas Ass'n v. U.S. Dep't of Energy*, 72 F.4th 1324, 1337 (D.C. Cir. 2023) ("Generally, the technical studies and data upon which the agency relies must be revealed for public evaluation. . . .") and *Conn. Light & Power Co. v. Nuclear Regulatory Comm'n Com.*, 673 F.2d 525, 530–31 (1982) ("An agency commits serious procedural error when it fails to reveal portions of the technical basis for a proposed rule in time to allow for meaningful commentary.") (*Id.*)

In response to the comments regarding units tested, DOE provided information on the CRE units tested in this rulemaking cycle in table IV.17 of the August 2024 NODA. DOE notes that Section 1.2 of the NODA support document DOE stated the year the test unit was purchased. Teardowns were conducted after purchase (*i.e.*, between 2017–2024). In the August 2024 NODA, DOE stated that, based on feedback in response to the October 2023 NOPR and November 2023 Public Meeting and additional test and teardown data conducted since the October 2023 NOPR, DOE updated certain design specifications and components assumed to be used in models at the baseline efficiency level in the NODA. 89 FR 68788, 68792. As stated in the August 2024 NODA, DOE conducted additional component teardowns and reviewed the teardown data it compiled in support of this rulemaking and observed that a significant number of units contained

electronically commutated motor (ECM) evaporator and condenser fan motors. *Id.* Therefore, based on DOE's teardown data, DOE presents a revised analysis in the August 2024 NODA with updated baseline fan motor components for certain equipment classes. *Id.*

Additionally, DOE provided the supporting spreadsheets that the analyses were based on for the June 2022 Preliminary Analysis, the October 2023 NOPR, the August 2024 NODA, and this final rule.

With respect to comments regarding the APA, DOE has met the APA's requirements as DOE has provided throughout this final rule, the final rule TSD, and the final rule supporting documents all of the details of the analysis conducted by DOE and the information relied upon in conducting that analysis.

In response to Zero Zone's comment regarding CRE connected to a remote condensing unit, as stated in section 1.2 of the August 2024 NODA support document, DOE did not conduct any testing on CRE with remote condensing units in support of this rulemaking. Instead, the analysis for directly analyzed remote equipment classes was based on the engineering spreadsheet model methodology of the March 2014 Final Rule, and DOE updated certain design specifications and design options for this rulemaking with current information, based on models currently available on the market, and supporting data and information provided during manufacturer interviews conducted during this rulemaking process. This approach was also supported by calibrations conducted on the self-contained CRE analysis for inputs that apply to both the self-contained analysis and the remote-condensing analysis.

When compiling the list of tested units for the August 2024 NODA and this final rule, DOE refined the October 2023 NOPR list of tested CRE that were used to support the engineering analysis, which resulted in a total of 64 units. DOE has provided anonymized data with the year purchased, refrigerant type, equipment class, volume or TDA, and daily energy consumption in table IV.17. DOE used the results of this testing as well as market research and manufacturer interviews to inform its engineering analysis spreadsheet for this final rule.

**Table IV.17 Summary of CRE Units Tested**

Year Purchased	Refrigerant Type	Equipment Class	Tested Volume (ft <sup>3</sup> ) or TDA (ft <sup>2</sup> )	Tested Daily Energy Consumption (kWh/day)
2018	R-134a	HCS.SC.M	12	1.20
2018	R-134a	VCT.SC.M	45.9	4.90
2018	R-404A	VOP.SC.M	14.94	27.39
2018	R-134a	SOC.SC.M	18.23	7.84
2018	R-404A	VCT.SC.L	49.2	16.76
2018	R-404A	VCT.SC.L	49.6	14.08
2018	R-404A	SVO.SC.M	8.72	15.71
2018	R-290	VCT.SC.M	49.01	3.040
2018	R-134a	VOP.SC.M	13.46	11.92
2018	R-404A	VCS.SC.L	50.1	9.35
2018	R-290	SVO.SC.M	15	14.09
2018	R-290	SVO.SC.M	15	18.34
2018	R-134a	VCS.SC.M	46.8	2.86
2018	R-404A	VOP.SC.M	16.1	28.38
2018	R-290	HCT.SC.I	5.2	2.44
2018	R-600a	HCS.SC.L	6.96	0.72
2018	R-290	VCT.SC.I	7.58	7.44
2018	R-134a	HCS.SC.M	11.97	1.19
2018	R-404A	VOP.SC.M	31.42	53.08
2018	R-404A	SVO.SC.M	17.92	25.46
2018	R-290	HCS.SC.M	12.84	0.77
2018	R-290	SOC.SC.M	20.18	4.85
2019	R-404A	VCT.SC.L	46.72	12.42
2019	R-290	VCS.SC.M	21.58	2.01
2019	R-290	VCT.SC.M	47.56	4.34
2019	R-134a	HCS.SC.M	12.54	1.07
2019	R-290	VCT.SC.M	12.98	1.41
2019	R-290	SOC.SC.M	12.87	2.19
2019	R-134a	HCS.SC.I	17.48	4.55
2019	R-450A	VCT.SC.M	24.14	2.40
2019	R-450A	VCT.SC.M	46.21	4.87
2019	R-450A	VCS.SC.M	38.7	3.07
2019	R-450A	VCS.SC.M	38.7	3.09
2019	R-404A	VCS.SC.L	21.22	5.63
2019	R-134a	SOC.SC.I	3.1	7.92
2019	R-290	VCS.SC.L	44.3	10.13
2019	R-404A	HZO.SC.M	31.74	27.57
2019	R-404A	VOP.SC.M	12.93	14.49
2019	R-290	VCS.SC.L	69.19	15.42
2019	R-404A	VCT.SC.L	44.25	13.63
2019	R-404A	VCT.SC.I	9.55	12.79
2019	R-290	HCT.SC.I	12.72	6.66
2019	R-290	HCT.SC.I	14.84	5.65
2019	R-290	VCS.SC.M	45.86	2.11
2019	R-290	VCT.SC.M	8.72	1.43
2019	R-134a	VCT.SC.M	23.42	2.21



2020	R-290	VCT.SC.M	23.9	2.66
2020	R-290	VCT.SC.L	45.52	8.93
2020	R-290	VCT.SC.L	22.14	7.91
2020	R-290	VCT.SC.M	41	3.78
2020	R-450A	VCT.SC.H	40.21	2.97
2020	R-450A	VCT.SC.H	18.73	1.75
2020	R-600a	VCT.SC.H	7.89	1.76
2020	R-513A	SOC.SC.H	29.17	13.27
2020	R-290	VCS.SC.M	38	1.66
2020	R-134a	VCS.SC.H	5.24	1.17
2020	R-290	VCS.SC.H	25.35	1.35
2021	R-600a	VCT.SC.H	3.3	0.61
2020	R-404A	VOP.SC.H	19.99	38.95
2017	R-134a	CB.SC.M	5.12	1.62
2018	R-404A	CB.SC.L	6.1	7.60
2023	R-290	CB.SC.M	6.94	1.28
2023	R-290	CB.SC.M	8.3	1.55
2023	R-290	CB.SC.M	7.4	2.29
2023	R-290	CB.SC.L	11.65	5.24
2023	R-290	CB.SC.L	9.90	5.10

#### Chef Base or Griddle Stand Test Data

In response to the October 2023 NOPR regarding the amended test conditions for chef bases or griddle stands in the September 2023 Test Procedure Final Rule, NAFEM commented that DOE has provided no empirical data in support of the conclusion that the amendments adopted in the September 2023 Test Procedure Final Rule will not alter the measured efficiency of CRE currently subject to energy conservation standards. (NAFEM, No. 83 at p. 13) NAFEM stated that, in the November 2023 Public Meeting, DOE stated it tested chef bases or griddle stands at the 75 °F ambient temperature and calibrated the engineering analysis to that condition, then cross walked that condition to the 86 °F condition. (*Id.*) NAFEM commented that when DOE was asked about test data at 86 °F, DOE stated it did not receive any data for that condition. (*Id.*) Continental and NAFEM disagreed with DOE's decision to use simulated estimates of energy consumption for chef base or griddle stand units under the newly instated conditions as a crosswalk in lieu of actual test results. (Continental, No. 86 at p. 3; NAFEM, No. 83 at pp. 13–14) In response to the August 2024 NODA, Continental stated that it disagrees with the inclusion of chef bases and griddle stands until sufficient testing has been conducted at prescribed conditions, and properly vetted. (Continental, No. 107 at p. 2)

In response to the comment from NAFEM, DOE notes that chef bases or griddle stands are not currently subject to energy conservation standards, therefore, NAFEM's comment about the September 2023 Test Procedure Final Rule not altering the measured efficiency of CRE currently subject to energy conservation standards is not applicable to chef bases or griddle stands.

In response to the comments from NAFEM and Continental about test data versus modeling energy consumption in the engineering spreadsheet, DOE performed additional testing on chef bases or griddle stands at an 86 °F ambient dry-bulb temperature, as summarized in table IV., in accordance with the amended test conditions for chef bases and griddle stands prescribed in the September 2023 Test Procedure Final Rule.

In response to the October 2023 NOPR, Hoshizaki, NAFEM, Continental, and Delfield commented requesting more information on how standards for chef bases or griddle stands were established because the amended test procedure requires a different ambient temperature than other CRE and whether testing had been conducted on chef base or griddle stand units. (Hoshizaki, No. 76 at p. 4; NAFEM, No. 83 at pp. 13–14; Continental, No. 86 at pp. 2–3; Delfield, No. 71 at p. 1)

In response to the October 2023 NOPR, Hoshizaki requested that DOE allow manufacturers to send chef bases

or griddle stands to third-party labs for testing over a 2-year period to see where energy levels should be set, and then grant manufacturers 3 years to make necessary changes to meet this new standard. (Hoshizaki, No. 76 at p. 4)

While DOE initially tested chef bases or griddle stands at a 75 °F ambient dry-bulb temperature to inform the October 2023 NOPR analysis, the September 2023 Test Procedure Final Rule amended the tested ambient dry-bulb temperature for chef bases or griddle stands from 75 °F to 86 °F; therefore, in the October 2023 NOPR DOE revised the chef bases or griddle stand analysis using the CRE engineering spreadsheet model to calculate the energy use at an 86 °F ambient dry-bulb temperature. In the October 2023 NOPR analysis, DOE had analyzed a saturated condensing temperature ("SCT") of 95 °F for all equipment classes, a 20-degree temperature difference with the 75 °F ambient temperature. To maintain a 20-degree temperature difference with the amended 86 °F ambient temperature for chef bases or griddle stands, in the analysis presented in the August 2024 NODA and this final rule, DOE analyzed a SCT of 106 °F for chef base or griddle stand equipment.<sup>77</sup>

In response to the August 2024 NODA, The CA IOUs commented that, changing engineering assumptions from

<sup>77</sup> See Section 1.3 of the NODA support document at <https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0090>.

75.2 °F to 86.0 °F ambient dry bulb temperature in the NODA engineering spreadsheet increases modeled energy use by 20.3% for chef base coolers (CB.SC.M) and 9.5% for chef base freezers (CB.SC.L). (CA IOUs, No. 113, at p. 5) The CA IOUs commented that they tested popular models of chef bases based on DOE's current test procedure at 75.2 °F and 86.0 °F. (*Id.*) The CA IOUs commented that their test data and DOE's test data from the NOPR TSD show significantly higher energy consumption increases than those indicated in the NODA engineering spreadsheet at 86 °F compared to 75 °F. (*Id.*) The CA IOUs commented that, since DEC is a function of refrigerated volume for chef bases, the percent difference in DEC from 75 °F to 86 °F should also be a function of refrigerated volume. (*Id.*) The CA IOUs commented that DOE should update its engineering analysis and use available test data to validate its engineering model, ensuring more accurate predictions of standard levels and energy savings. (*Id.*)

In response to the CA IOUs comment, DOE notes that the analysis supporting the August 2024 NODA and this final rule for chef bases or griddle stands was not based on a percent difference of tested energy use from 75 °F to 86 °F. The chef base or griddle stand test data conducted at 86 °F and the subsequent teardown information from those test units were used to inform the engineering spreadsheet assumptions and calculations used to conduct this analysis. DOE did not use the test data conducted at 75 °F to inform the August 2024 NODA or this final rule analysis. Therefore, the CA IOUs request that DOE make the percent difference in DEC from 75 °F to 86 °F a function of refrigerated volume is irrelevant to this analysis. DOE agrees with the CA IOUs comment in response to the August 2024 NODA that the daily energy consumption values for the units the CA IOUs tested are consistent with DOE's data. (The CA IOUs, No. 113, at p. 2).

Since the October 2023 NOPR, DOE has updated certain baseline design specifications for chef bases or griddle stands including: the number of evaporator fans for CB.SC.L, the infiltrated air mass flow rate assumption for CB.SC.M and CB.SC.L, the discharge air temperature ("DAT") for CB.SC.M, and the baseline evaporator temperature ("SET") for CB.SC.L. For more details, see appendix 5A of the final rule TSD. As previously discussed in section IV.C.1.a.iii of this document, updating certain baseline design specifications is

consistent with the approach in the March 2014 Final Rule.<sup>78</sup>

#### e. Development of Standard Equations

In the October 2023 NOPR, in three directly analyzed equipment classes, VCT.SC.M, VCS.SC.I, and HCT.SC.I, DOE tentatively determined to maintain the current standard equation intercept and calculated a slope based on the current standard intercept and the proposed energy use level at the representative volume or TDA. 88 FR 70196, 70216–70217 This approach was consistent with the approach taken in the March 2014 Final Rule for certain classes, in which DOE retained the offset factors for classes DOE had calculated the offset factor for in the March 2009 CRE final rule, as DOE stated in the March 2014 Final Rule that it believed that those figures continued to represent the end effects inherent in the operation of those equipment types.<sup>79</sup>

In response to the October 2023 NOPR, Zero Zone commented that it believes that DOE's approach in the October 2023 NOPR to keep the current standard equation intercept and calculate a new slope based on proposed use level and representative volume approach is incorrect, resulting in a close to 50-percent reduction in allowable energy use. (Zero Zone, No. 75 at p. 2)

Hoshizaki stated that equations for the model families result in curves that do not accurately give a leveled curve that provides nominal energy reduction across the full range of volumes. (Hoshizaki, No. 76 at p. 3) Hoshizaki commented that areas of the curve show a 10–20-percent reduction and some areas range from 30–60 percent reductions, which are not feasible based on the technology available today. (*Id.*)

In response to Zero Zone's and Hoshizaki's comments regarding the slope, DOE notes that in the October 2023 NOPR, consistent with the analysis described in the March 2014 Final Rule TSD for certain classes in which DOE retained the offset factors for classes DOE had calculated the offset factor for in the March 2009 CRE final rule, for all classes except VCT.SC.M, VCS.SC.I, and HCT.SC.I, DOE adjusted both the slope and intercept based on the percent reduction for the selected EL to maintain an equal percent reduction across the volume or TDA range. 88 FR

70196, 70217. DOE has updated its methodology in this final rule, consistent with the equations presented in the August 2024 NODA, to apply the energy use reduction percentage to the baseline energy use equation's slope and intercept for all classes. For VCT.SC.M, this is consistent with the March 2014 Final Rule TSD, where DOE adjusted the slope and intercept for the EPACK 2005 equipment classes. See section 5.8 of the March 2014 Final Rule TSD for more details. Additionally, as discussed in section IV.A.1.b, DOE is maintaining the 49 ft<sup>3</sup> representative volume for the VCT.SC.M ( $V \leq 100$ ) class in this final rule, which is supported by an analysis conducted by DOE to confirm that the representative analysis at 49 ft<sup>3</sup> is also representative for volumes less than 49 ft<sup>3</sup>.

Updating the standard line intercept for certain classes is consistent with the approach in the March 2014 Final Rule, where DOE adjusted the offset factors, or y-intercept, for certain classes in response to comments received on the NOPR. See 79 FR 17725, 17742.

Furthermore, as compared to the October 2023 NOPR, DOE is adopting less stringent efficiency levels in this final rule for the majority of equipment classes.

Zero Zone recommended that DOE review the EPA ENERGY STAR approach and the resulting multiple slope equations for different volumes. (Zero Zone, No. 75 at p. 2) Zero Zone commented this approach would consider the additional compressor units required to maintain safe food product temperatures in medium-temperature self-contained equipment. (*Id.*) Zero Zone added that EPA did not identify significant energy improvements for commercial refrigerators and freezers in its November 2022 ENERGY STAR 5.0 Commercial Refrigerators and Freezers Specification,<sup>80</sup> and Zero Zone recommended that DOE should follow EPA's analysis and not change the efficiency level for this product. (*Id.*)

In response to the August 2024 NODA, Zero Zone commented that DOE should not use a single line, 2-point formula, as energy use in large self-contained equipment is not strictly proportional to the volume of the unit. (Zero Zone, No. 114 at p. 2) Zero Zone requested DOE review EPA's ENERGY STAR levels for SC.M for an example of energy level variation as equipment volume increases. (*Id.*)

<sup>78</sup> See tables 5.A.2.2 of the NOPR and March 2014 Final Rule TSD, available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0051](https://www.regulations.gov/document/EERE-2010-BT-STD-0003-0051) and [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](https://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).

<sup>79</sup> See section 5.8 at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](https://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).

<sup>80</sup> See [www.energystar.gov/products/commercial\\_refrigerators\\_freezers/partners?\\_gl=1\\*\\_mzqc33\\*\\_ga\\*MTkwMzYyNTg3LjE3MDU0MjQ1OTk.\\*\\_ga\\_S0KJT7VVLQ6\\*MTcxNDA4Mzg1MC4xNy4xLjE3MTQwODM4NTMuMC4wLjA](https://www.energystar.gov/products/commercial_refrigerators_freezers/partners?_gl=1*_mzqc33*_ga*MTkwMzYyNTg3LjE3MDU0MjQ1OTk.*_ga_S0KJT7VVLQ6*MTcxNDA4Mzg1MC4xNy4xLjE3MTQwODM4NTMuMC4wLjA).



In response to the comment from Zero Zone, the standard lines for the analyzed classes and capacity ranges in this final rule reflect an even application of the energy use percent reduction of the representative capacity across the capacity range of each equipment class. DOE notes that DOE's current, new, and amended standards do allow for more energy use as capacity increases, and DOE is continuing to analyze the large capacities of the seven self-contained equipment classes as discussed in section II.B.3 of this document.

#### f. Engineering Spreadsheet

In response to the October 2023 NOPR, ITW commented that DOE's October 2023 NOPR engineering spreadsheet should account for component performance variability. (ITW, No. 82 at p. 5) ITW provided the example of compressors, which are subject to variability in their EER due to variations in motor efficiency, copper slot fill, magnetic properties of lamination steel, machining tolerances, etc. (*Id.*) ITW commented that the extent of this normal variation was well documented in a joint study conducted by AHRI and the Association of European Refrigeration Component Manufacturers ("ASERCOM") in 2017, which reported a normal expected variation of between 5 and 10 percent in the compressor EER. (*Id.*) Based on the above-mentioned considerations for variability, ITW requested that DOE account for a 5–10 percent discount factor to the system energy efficiency as part of any baseline or energy improvement scenario calculation. (*Id.*)

In the March 2014 Final Rule, DOE updated its compressor assumptions in response to comments received on the NOPR. 79 FR 17725, 17760. In this final rule, DOE is also updating its compressor assumptions in response to commenter feedback. With respect to the comment from ITW, DOE reviewed the white paper ITW provided, which is also referenced by the AHRI 540 compressor performance rating standard ("AHRI 540"), and DOE is applying a 5-percent increase in energy use for all compressors to account for the performance prediction uncertainty as a result of curve-fitting compressor performance maps in this final rule. This adjustment is made by increasing the overall compressor power by 5 percent in the engineering spreadsheet and aligns with commenters' feedback that a 5–10 percent increase in energy use for all compressors should be included to account for the potential variability in compressor performance.

See the final rule engineering spreadsheet for further details.

Hillphoenix commented that the engineering spreadsheet contains an error for calculating the efficiency of variable-speed compressors. (*Id.* at p. 11) Hillphoenix commented also that all except three classes that used the CP4 code as a selected option show "VALUE" in the kWh cell for evaporator fan motors, condenser fan motors, and compressors for the selected TSL 5 energy level. (*Id.*) Hillphoenix stated that classes with CP4 code and "VALUE" showing in Excel include VOP.SC.M, SVO.SC.M, HZO.SC.M, HZO.SC.L, SOC.SC.M, VCT.SC.L, VCS.SC.H, VCS.SC.L, and VCS.SC.I. (*Id.*)

With respect to the comment from Hillphoenix regarding errors in the engineering spreadsheet, DOE recommends that manufacturers follow the instructions in the engineering spreadsheet on enabling iterative calculations and refreshing calculations after changing equipment classes. Without more detailed information, DOE is unable to further assist in a response to the comment from Hillphoenix.

Hillphoenix commented that the VCT.SC.M equipment class selected EL in the October 2023 NOPR does not pass the proposed energy limit. (Hillphoenix, No. 77 at p. 11) Hillphoenix commented that the formula for this error from the October 2023 NOPR is  $(0.05 * 49 \text{ ft}^3 + 0.9)$  and equals a 3.35 kWh calculated energy limit, and EL 3 was selected for this class and has an energy consumption of 3.52 kWh, which is ~ 5 percent over the proposed energy limit. (*Id.*)

In response to the comment from Hillphoenix, in the October 2023 NOPR, the proposed maximum energy use formula for the VCT.SC.M equipment class was  $0.054 \times V + 0.86$ . Using the representative volume for that equipment class, 49.00 ft<sup>3</sup>, to calculate the maximum energy use proposed in the October 2023 NOPR for that class results in 3.506 kWh/day. In the October 2023 NOPR, DOE proposed EL 3 for the VCT.SC.M class, which was associated with an energy use of 3.515 kWh/day. These values are 0.3 percent different from each other. The equation and values that Hillphoenix cited are different from the values in the October 2023 NOPR.

#### g. Capacity Metrics

In response to the October 2023 NOPR, Zero Zone stated that some manufacturers have taken advantage of the energy formula's use of refrigerated volume and increased their equipment's

volume in order to have more allowable energy. (Zero Zone, No. 75 at p. 3) Zero Zone stated its belief that this approach offers limited value to the end user and does not address the goal of energy efficiency. (*Id.*) Zero Zone recommended the use of TDA for energy calculations of product classes that have transparent doors or no doors. (*Id.*)

While DOE acknowledges that some equipment with unique designs could have more or less TDA than the TDA of the representative unit analyzed at a specific volume, DOE currently assumes that these designs are manufactured for specific end-use cases and are not representative of the equipment class. DOE considers all models when developing the representative design specifications and has presented updated design specifications in this final rule. As stated in the October 2023 NOPR, given the mixed response regarding revising the capacity metrics for equipment classes, DOE has not evaluated revising the capacity metrics for any equipment classes. 88 FR 70196, 70217. In the absence of clear data to support a change in metric, it is not appropriate for DOE to make a change at this time.

#### 2. Cost Analysis

The cost analysis portion of the engineering analysis is conducted using one or a combination of cost approaches. The selection of cost approach depends on a suite of factors, including the availability and reliability of public information, characteristics of the regulated equipment, the availability and timeliness of purchasing the equipment on the market. The cost approaches are summarized as follows:

- Physical teardowns: Under this approach, DOE physically dismantles a commercially available equipment component-by-component, to develop a detailed bill of materials for the equipment.

- Catalog teardowns: In lieu of physically deconstructing equipment, DOE identifies each component using parts diagrams (available from manufacturer websites or appliance repair websites, for example) to develop the bill of materials for the equipment.

- Price surveys: If neither a physical nor catalog teardown is feasible (*e.g.*, for tightly integrated products such as fluorescent lamps, which are infeasible to disassemble and for which parts diagrams are unavailable), cost-prohibitive, or otherwise impractical (*e.g.*, large commercial boilers), DOE conducts price surveys using publicly available pricing data published on major online retailer websites and/or by

soliciting prices from distributors and other commercial channels.

In the present case, DOE conducted the analysis using physical and catalog teardowns. Except for updates presented in this section that are consistent with the August 2024 NODA, the cost analysis used in this final rule is the same as the cost analysis in the October 2023 NOPR. See chapter 5 of the final rule TSD for additional details.

The resulting bill of materials provides the basis for the MPC estimates for equipment at various efficiency levels spanning the full range of efficiencies from the baseline to max-tech.

In the October 2023 NOPR, DOE requested comment on the method for estimating manufacturer production costs. 88 FR 70196, 70236. In the August 2024 NODA, DOE also requested comment on the updated analysis that was presented. 89 FR 68788, 68832.

#### a. General Approach of the Cost Analysis

In response to the October 2023 NOPR, Hussmann and AHRI requested that DOE clarify its question about the method for estimating manufacturer production costs and asked if DOE is referring to 2014 or 2023 cost information. (AHRI, No. 81 at p. 8; Hussmann, No. 80 at p. 6)

In response to the October 2023 NOPR, Hoshizaki requested more information on price-learning models that were reviewed with specific manufacturers and model numbers, as well as the parts that were evaluated for efficiency gains with manufacturer names, part numbers, and 2023 costs to verify that the parts analyzed were from 2022 and not 2014. (Hoshizaki, No. 76 at p. 4) Hoshizaki commented that DOE mentioned in the November 2023 public meeting that costs were adjusted for inflation, but the last 3 years have not been a normal inflation track, with parts and materials shortages that have led to vast price increases and longer lead times. (*Id.*) Hoshizaki commented that verification of costs to 2023 figures would be helpful to validate cost to change to higher energy efficiency. (*Id.*)

As discussed in the October 2023 NOPR, DOE updated the October 2023 NOPR analysis to reflect current inflation rates at the time of the analysis, which reflects 2022 dollars. 88 FR 70196, 70235. DOE acknowledges that there have been abnormal price trends, but notes that DOE uses inflation indices specific to the materials included in CRE to update its cost analysis in order to account for any abnormal price trends. DOE also notes that for raw metal materials, DOE uses

the 5-year average prices, further described in chapter 5 of the final rule TSD. In response to Hussmann and AHRI, DOE's request for comment on manufacturer production costs in the October 2023 NOPR was referring to the 2022 dollar year analyzed in the October 2023 NOPR.

In response to the October 2023 NOPR, Zero Zone requested that if DOE maintains the current proposed levels, DOE should reevaluate the case cost analysis to account for redesign and new foam fixtures, as Zero Zone will need to make these investments to achieve a compliant product. (Zero Zone, No. 75 at p. 3) Zero Zone further requested that DOE reevaluate the engineering analysis and the proposed energy conservation standard for the VCT.SC.M product class, as well as the cost analysis for product classes anticipated to switch to R-290. (*Id.*)

In response to the comment from Zero Zone, in this final rule, DOE analyzed design option steps based on what is most representative of the current market, and DOE does not anticipate manufacturers needing to increase insulation thickness to meet the current standard and has screened out increased insulation thickness as described in section IV.B.1.a. In this final rule, DOE reviewed the cost analysis to ensure that the costs reflected R-290 designs for equipment classes in which the representative baseline was based on R-290. For further details on the cost analysis, see chapter 5 of the final rule TSD. In addition to accounting for the switch to R-290 in its cost analysis, DOE also analyzed investments required by the industry to make the switch. For details on those conversion costs, see section IV.J.3.a of this document.

In response to the October 2023 NOPR, NAMA commented that there were significant discrepancies in design option costs across equipment classes, and included a table of design options for four different equipment classes that had different costs for design options including condenser fan motors, occupancy sensors, microchannel heat exchangers, improved-insulation doors, and variable speed compressors. (NAMA, No. 85 at pp. 13–14) NAMA also recommended that DOE check the accuracy of estimates for machines under 30 cubic feet in capacity. (*Id.* at p. 14)

In response to the comment from NAMA, DOE did not receive data to suggest that machines under 30 ft<sup>3</sup> in capacity would use design options significantly different than larger equipment; therefore, DOE has not considered different costs for machines under 30 ft<sup>3</sup> in the analysis in this final

rule. In response to NAMA's comment on design option cost differences, DOE notes that the costs for the design options that NAMA listed differ for each equipment class due to their representative units' different design specifications, including unit dimensions, capacity, and power requirements. For example, there is significant difference between costs for improved-insulation door design options for each equipment class because each equipment class representative unit has a different sized door. For further discussion on how DOE determined representative unit design specifications, see section IV.C.1 of this document and chapter 5 of the final rule TSD.

In response to the October 2023 NOPR, NAMA recommended that DOE refer to labor cost data from 2021–2023, not 2018, because the latter does not reflect overtime wages in a labor shortage, which contributes to the financial burden on manufacturers. (NAMA, No. 85 at p. 15)

DOE notes that at the NOPR stage, the unburdened fabrication and assembly wages—factors that affect the labor component of the MPC—were determined to be \$16.00 per hour based on previous feedback from manufacturer interviews. DOE is unclear about NAMA's reference to using labor cost data from 2018. After reviewing recent data from the Bureau of Labor Statistics ("BLS"),<sup>81</sup> DOE updated its labor rates for the final rule engineering analysis to \$22.00 per hour for unburdened assembly wages and \$24.00 per hour for unburdened fabrication process wages. This update in the final rule analysis results in higher labor costs to make CREs of all efficiencies. Additionally, DOE accounts for fully burdened labor costs by estimating additional costs to employers associated with providing employee benefits. See chapter 5 of the final rule TSD for further details.

As discussed in the October 2023 NOPR, DOE updated the NOPR analysis to reflect current inflation rates at the time of the analysis, which reflects 2022 dollars. 88 FR 70196, 70235. In this final rule, DOE uses 2023 dollars.

#### b. Costs of Specific Components

In response to the October 2023 NOPR, NAMA stated that DOE significantly underestimates the cost of components that comprise a CRE unit. (NAMA, No. 85 at pp. 10–11, 13–14) NAMA commented that DOE should not base the cost of design options on one

<sup>81</sup> Occupational wage statistics data are available at [www.bls.gov/oes/](http://www.bls.gov/oes/).



product category to another with spreads of 400 percent. (*Id.* at p. 13)

In response to the October 2023 NOPR, NAMA also commented that it does not agree with the cost of the change in DC condenser fan options as shown in the October 2023 NOPR TSD, as NAMA found that the cost for the motors was greater than \$20 based on what its companies paid for the motor, the installation, and the capital costs. (NAMA, No. 85 at p. 23)

In response to the comment from NAMA regarding the cost of DC condenser fan motors, DOE notes that, in the final rule engineering analysis, DOE analyzed costs for brushless DC fan motors ranging between \$23.71 and \$28.80, depending on the rated wattage of the motor. In response to the comment from NAMA regarding the accuracy of component costs, DOE notes that costs were obtained from teardown analyses as well as data from manufacturer feedback. For further details on the cost analysis, see chapter 5 of the Final Rule TSD.

In response to the October 2023 NOPR, NAMA commented that for the 2022 preliminary analysis, DOE estimated a cost increase of \$167 for improved insulated doors; however, NAMA estimated that the cost today is expected to be over \$500, which would result in a negative payback for over 20 years. (NAMA, No. 85 at p. 25)

Regarding the comment from NAMA about the cost increase for improved insulated doors, NAMA has not provided information, such as the size, number of panes, and fill type, about the door referenced in their comment, making it difficult to provide an accurate comparison. DOE also notes it appears that NAMA is referencing the VCT.SC.M results provided in the June 2022 Preliminary Analysis, for which the “high performance door” design option for VCT.SC.M costs approximately \$167 more than the previous design option step, and comparing that cost increase to the total cost of the door. In this final rule, consistent with the August 2024 NODA, DOE revised the door cost estimates resulting in a total cost (*i.e.*, not incremental cost) of around \$380 for triple pane, argon filled glass packs on the VCT.SC.M representative unit analyzed in this final rule. DOE notes that triple pane, argon filled glass packs were the most efficient door design option analyzed at the TSL level finalized in this final rule (TSL 3), and that at TSL 3 for the VCT equipment class, the subject of NAMA’s comment, DOE did not analyze a door design option beyond the baseline to improve efficiency. In this final rule analysis,

DOE has updated the cost of the door design but adjusted for differences in market size and purchasing volume.

In response to the October 2023 NOPR, NAMA commented that when estimating costs for microchannel condenser coils, DOE did not include a fully burdened, amortized cost of engineering, design, creation of test models, testing, tooling, factory assembly line upgrades, fixtures, molding changes, packaging for larger and heavier machines, and other costs. (NAMA, No. 85 at p. 26)

With respect to the comment from NAMA regarding microchannel condenser coils, DOE is no longer considering microchannel condenser coils as a design option in this final rule, and has screened out this design option as discussed in section IV.B.1.g.

In response to the August 2024 NODA, NAMA commented that, while DOE did adjust some of the NOPR costs in the NODA TSD, several design options (*e.g.*, krypton filled doors, brushless DC condenser fan motors, argon filled triple pane doors, occupancy sensors with dimming) are shown as improving efficiency by amounts not proven in NAMA’s testing, and the cost is significantly higher than what is shown. (NAMA, No. 112 at p. 6)

With regards to the comment from NAMA, DOE maintains its position that its door costs are representative of the industry based on commercial available door designs, performance of commercial available door designs, current costs of various door technologies, as well as feedback directly from manufacturers. NAMA did not provide additional detail to support their complaints including the testing they reference in the comment. Therefore, DOE has not made any adjustments to the engineering analysis from the August 2024 NODA.

#### c. Variable-Speed Compressor

In response to the October 2023 NOPR, NAMA commented that the estimated cost of a VSC, \$200, has not changed since its response to the June 2022 Preliminary Analysis, except for a 10-percent increase due to compressor manufacturer pricing. (NAMA, No. 85 at p. 24) NAMA commented that DOE underestimates the purchase price, the cost of the other parts necessary to make a VSC work (*i.e.*, computer controls), and the changes to the cooler. (*Id.*)

DOE disagrees with the comment from NAMA that DOE is underestimating the cost of the variable-speed compressors. In the October 2023 NOPR, DOE proposed that the MPC of a VSC at the representative volume for

VCT.SC.M class was \$220.52, consistent with NAMA’s comment that the estimated cost of a VSC is \$200 plus a 10-percent increase. \$94 represents the cost differential between the cost of the single-speed compressor and a variable-speed compressor. In this final rule, DOE is maintaining the cost differential of \$94.

DOE notes that NAMA did not elaborate on what it meant by “computer controls.” NAMA may have been referring to the need for electronic controls to set appropriate compressor speeds. DOE has determined that the cost to add additional hardware to implement variable-speed control as compared to single-speed control using an electronic control platform would be minimal (*i.e.*, the required sensors would already be in place, and the cost of any required additional microprocessor capacity would be minimal).

In addition, DOE received confidential comments related to the electronic controls assumed in the baseline in response to the October 2023 NOPR.

In response to the August 2024 NODA, Hillphoenix commented that one of the largest North American manufacturers of compressors estimates that the variable-speed compressor controller cost would be a 100 percent increase over fixed speed compressor cost, and that DOE neglected to account for cost increase of a required variable-speed compressor controller and additional components. (Hillphoenix, No. 110 at p. 4) Hillphoenix stated that there are additional costs associated with variable speed compressors, such as programming, installation, training, and the increased time for “end of line” testing that are not reflected in the engineering analysis. (*Id.* at p. 4–5)

Based on the preponderance of CRE units DOE tested and tore down in support of this CRE rulemaking that are currently using electronic controls, DOE determined that CRE already have the other parts necessary to make a variable-speed compressor work (*e.g.*, electronic controls are already present in existing CRE). Therefore, the main difference between single-speed and variable-speed compressors that would contribute significantly to cost is the inclusion of an inverter drive to control the speed of the compressor, which DOE has accounted for in the VSC design option MPC.

Further, in response to commenter feedback and based on the CRE units DOE tested and tore down, DOE has updated the analysis to reflect the use of electronic controls at the baseline

efficiency level for all equipment classes in this final rule.

In response to the comment from Hillphoenix that DOE neglected to account for additional costs associated with programming, installation, training, and increased testing time, DOE notes that it accounts for non-production costs (*i.e.*, selling, general and administrative expenses (“SG&A”), research and development (“R&D”) expenses, and interest) as part of the manufacturer markup, described in section IV.C.2.f of this document and chapter 12 of this final rule TSD. Additionally, research and development investments associated with variable-speed compressors were accounted for as part of the product conversion costs in the manufacturing impact analysis, as discussed in section IV.J.3.a of this document.

#### d. Doors With Krypton Gas Fill

In response to the October 2023 NOPR, Zero Zone stated that 40 percent of krypton gas is manufactured in Ukraine and the war makes obtaining krypton gas difficult. (Zero Zone, No. 75 at pp. 3–4) Zero Zone commented that its suppliers estimate krypton would increase the cost of a door by \$35, whereas DOE estimated a cost increase of \$5–6. (*Id.* at p. 4)

DOE reviewed current krypton gas prices and has observed that a cost increase of approximately \$30, based on the representative unit sizes analyzed for self-contained VCT units, is representative of the current market, consistent with the comment from Zero Zone, and DOE has presented updated costs for doors with krypton gas fill in this final rule that are consistent with the August 2024 NODA. This change is similar with the March 2014 Final Rule, where DOE updated the cost assumptions for certain door design options.<sup>82</sup>

In response to the August 2024 NODA, Hillphoenix, Continental, Hussmann, AHRI, and Zero Zone agreed with DOE’s observation that triple-pane doors with krypton gas are significantly more costly than with argon. (Hillphoenix, No. 110 at p. 5; Continental, No. 107 at p. 2; Hussmann, No. 108 at p. 3; AHRI, No. 104 at p. 8; Zero Zone, No. 114 at p. 2)

Therefore, in this final rule, consistent with commenters, DOE has maintained the August 2024 NODA values for its

pricing of triple-pane doors with krypton gas.

#### e. Cost-Efficiency Results

The results of the engineering analysis are reported as cost-efficiency data (or “curves”) in the form of daily energy consumption (in kWh) versus MPC (in dollars). DOE developed curves representing the primary equipment classes. The methodology for developing the curves started with determining the energy consumption for baseline equipment and MPCs for this equipment. Above the baseline, design options were implemented until all available technologies were employed (*i.e.*, at a max-tech level). DOE presents these results in chapter 5 of the final rule TSD. See chapter 5 of the final rule TSD for additional details on the engineering analysis and appendix 5B of the final rule TSD for complete cost-efficiency results.

#### Design Option Ordering

Based on all the comments received in response to the October 2023 NOPR and August 2024 NODA, and consistent with the precedent set by the March 2014 Final Rule, DOE has reordered the design options in the cost-efficiency results based on cost-effectiveness and likely order of implementation.<sup>83</sup> For more details on the updated design option ordering, see chapter 5 of the final rule TSD.

#### f. Manufacturer Markup

To account for manufacturers’ non-production costs and profit margin, DOE applies a multiplier (the manufacturer markup) to the MPC. The resulting manufacturer selling price (“MSP”) is the price at which the manufacturer distributes a unit into commerce. DOE developed an industry average manufacturer markup by examining the prior CRE rulemaking and annual Securities and Exchange Commission (“SEC”) 10–K reports<sup>84</sup> filed by publicly traded manufacturers primarily engaged in commercial refrigeration manufacturing and whose combined equipment range includes CRE. 79 FR 17725, 17758. As discussed in the following paragraphs, DOE revised the industry average manufacturer markup for this final rule analysis based on

stakeholder comments. See section IV.J.2.d of this document and chapter 12 of the final rule TSD for additional information on the manufacturer markup.

In response to the October 2023 NOPR, Hillphoenix commented that the manufacturer markup of 1.40 used in the October 2023 NOPR is high based on competitive market conditions. (Hillphoenix, No. 77 at p. 7) Hillphoenix commented that the NOPR Engineering Analysis Spreadsheet Model<sup>85</sup> referenced a manufacturer markup of 1.42. (*Id.*) In response to the August 2024 NODA, Hillphoenix commented that DOE’s suggested manufacturer markup value of 1.38 used in the August 2024 NODA was still too high based on the current competitive market pricing conditions and not representative of the CRE industry. (Hillphoenix, No. 110 at p. 5)

With respect to the comments from Hillphoenix, DOE developed the industry average manufacturer markup of 1.40 used in the October 2023 NOPR by reviewing prior CRE rulemakings, SEC Form 10–K reports, feedback gathered during confidential manufacturer interviews conducted in advance of the October 2023 NOPR, and market share weights. For the August 2024 NODA, DOE reassessed its manufacturer markup in response to stakeholder comments and adjusted its estimate using manufacturer feedback and market share weights. As a result, DOE used a manufacturer markup of 1.38 for the August 2024 NODA. DOE notes that the manufacturer markup of 1.38 is meant to represent the overall CRE industry, on average. DOE understands that manufacturer markups can vary by manufacturer, model, feature, *etc.* Based on the information available, DOE maintains an industry average manufacturer markup of 1.38 for all CRE equipment classes in this final rule analysis (*i.e.*, the manufacturer markup used in the LCC and PBP analyses and MIA), consistent with the August 2024 NODA. The Engineering Analysis Spreadsheet Model developed for this final rule also reflects a manufacturer markup of 1.38.<sup>86</sup>

NAMA stated that DOE’s method for estimating manufacturing production costs is inaccurate, due to lack of inclusion of costs for testing, outside certification of energy, outside certification of safety, tooling, and amortization of other factory costs,

<sup>82</sup> See the NOPR and March 2014 Final Rule engineering spreadsheets available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0098](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0098) and [www.regulations.gov/document/EERE-2010-BT-STD-0003-0059](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0059), respectively.

<sup>83</sup> See the NOPR TSD and the March 2014 Final Rule TSD for more details on changes to the design option ordering in the 2014 Final Rule. The NOPR TSD is available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0051](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0051) and the March 2014 Final Rule TSD is available at [www.regulations.gov/document/EERE-2010-BT-STD-0003-0102](http://www.regulations.gov/document/EERE-2010-BT-STD-0003-0102).

<sup>84</sup> SEC’s Electronic Data Gathering, Analysis, and Retrieval system is available at [www.sec.gov/edgar/searchedgar/companysearch](http://www.sec.gov/edgar/searchedgar/companysearch) (last accessed April 15, 2024).

<sup>85</sup> Available at [www.regulations.gov/document/EERE-2017-BT-STD-0007-0055](http://www.regulations.gov/document/EERE-2017-BT-STD-0007-0055).

<sup>86</sup> The Final Rule Engineering Analysis Spreadsheet Model is available at [www.regulations.gov/docket/EERE-2017-BT-STD-0007/document](http://www.regulations.gov/docket/EERE-2017-BT-STD-0007/document).



along with inaccurate estimation of units over which tooling and manufacturing fixtures are spread. (NAMA, No. 85 at p. 30) NAMA recommended that DOE restructure the system for estimating energy savings and cost analysis. (*Id.*)

NAMA commented also that many of the analyzed design options, such as specialized glass doors, microchannel condensers, occupancy sensors with dimmer controls, and variable speed compressors, would result in additional installation time, training, and many other skill considerations compared with baseline equipment. (NAMA, No. 85 at p. 31)

Regarding the comments on testing and certification costs, DOE accounts for manufacturers' non-production costs, including selling, general and administrative expenses, and research and development expenses (*e.g.*, testing, certification, marketing costs) in its MSP through the application of a manufacturer markup to the MPCs. As such, DOE notes that the MSPs derived in the engineering analysis, which are then used in the LCC and PBP analyses and MIA, incorporate industry average research and development expenses (and other non-production costs, along with profit). DOE also accounts for the one-time, upfront investments in research, development, testing, marketing, and other non-capitalized costs necessary to make product designs comply with new or amended energy conservation standards (*i.e.*, product conversion costs) in its MIA. See section IV.J.2.c of this document or chapter 12 of the final rule TSD for additional information on conversion costs.

Regarding the comment on tooling and equipment costs, DOE accounts for manufacturing equipment, tooling, and building depreciation in its MPCs and the one-time, upfront investments in property, plant, and equipment necessary to adapt or change existing production facilities (*i.e.*, capital conversion costs) in its MIA. As such, DOE notes that the depreciation component of the MPCs in the engineering analysis require estimates of capital investments (*e.g.*, tooling, fixtures, equipment). To estimate those capital investments for the engineering analysis, DOE uses data collected from teardowns and manufacturer interviews and estimated annual production volumes for each equipment class to model a "greenfield" facility—using brand-new equipment that has not depreciated through use—which includes the equipment, tooling, and space requirements necessary to carry out the manufacturing processes on a representative unit. See chapter 5 of the

final rule TSD for additional details on the cost model and estimation of MPCs.

#### D. Markups Analysis

The markups analysis develops appropriate markups (*e.g.*, distributor markups, retailer markups, contractor markups) in the distribution chain and sales taxes to convert the MSP estimates derived in the engineering analysis to consumer prices, which are then used in the LCC and PBP analysis. At each step in the distribution channel, companies mark up the price of the equipment to cover business costs and profit margin.

As part of the analysis, DOE identifies key market participants and distribution channels. In the October 2023 NOPR, DOE considered the following distribution channels:

- 1a. Contractor channel with replacement: Manufacturer → Wholesaler → Mechanical Contractor → Consumer
- 1b. Contractor channel with new construction: Manufacturer → Wholesaler → Mechanical Contractor → General Contractor → Consumer
2. Wholesale channel: Manufacturer → Wholesaler → Consumer
- 3a. National account channel: Manufacturer → Consumer
- 3b. National account channel with general contractor: Manufacturer → General Contractor → Consumer

88 FR 70196, 70236.

In response to the October 2023 NOPR, AHRI suggested that DOE update channel 1a and 1b, create additional channels for reused or refurbished equipment, and refer to consumers as "end-users" because the term "consumer" may imply individuals or families. (AHRI, No. 81 at p. 9) AHRI also recommended that DOE include other CRE purchaser categories, such as buyers' clubs, restaurant consortia, food service consultants, and governmental bids. (*Id.*)

In consideration of the feedback from AHRI, DOE determined that the slight update to channels 1a and 1b does not impact the overall markup estimation for those channels. With regard to the suggested addition of distribution channels for reused or refurbished equipment, DOE notes that such equipment is not subject to new standards; therefore, DOE did not consider such distribution channels in the markups analysis. However, refurbishments were considered in the LCC analysis by adjusting the mean lifetime distribution assumptions and assigning a credit equivalent to the residual value of the used equipment at the selling year (see section IV.F of this document for details). DOE clarifies that

it considers all purchasers of CRE in its analyses and is using the terms CRE "purchaser" and "consumer" interchangeably in this document.

NAMA recommended that DOE consider additional channels that involve the brand owner who specifies the performance of the equipment and then sells the equipment to a bottling company, which then passes the equipment down to a local retailer. (NAMA, No. 85 at p. 30) DOE appreciates the comment submitted by NAMA. DOE understands that NAMA is referring to the situation in which CRE are manufactured or packaged for sale under the name of a third-party company (*i.e.*, the brand owner) rather than that of the OEM. As part of its market and technology assessment, DOE reviews public equipment databases to identify the companies that import, private label, produce, or manufacture covered CRE. DOE identified OEMs by reviewing information from manufacturer websites, import and export data (*e.g.*, bills of lading from ImportYeti),<sup>87</sup> and basic model numbers. As part of that process, DOE also determined the owner of each brand listed in DOE's CCD, using the U.S. Patent and Trademark Office's Trademark Search<sup>88</sup> and other public sources (*e.g.*, trademark information from JUSTIA).<sup>89</sup> Based on a review of DOE's CCD, DOE estimates that approximately 10 to 12 percent of individual CRE model listings in its CCD are certified and marketed under a trademarked brand not owned by the actual OEM. See chapter 3 of the final rule TSD for additional information on DOE's market review.

DOE developed baseline and incremental markups for each actor in the distribution chain. Baseline markups are applied to the price of equipment with baseline efficiency, while incremental markups are applied to the difference in price between baseline and higher-efficiency models (the incremental cost increase). The incremental markup is typically less than the baseline markup and is designed to maintain similar per-unit operating profit before and after new or amended standards.<sup>90</sup>

<sup>87</sup> ImportYeti, LLC. "ImportYeti." Available at: [www.importyeti.com/](http://www.importyeti.com/) (Last accessed April 25, 2024).

<sup>88</sup> The U.S. Patent and Trademark Office's Trademark Search is available at [tmsearch.uspto.gov/search/search-information](https://tmsearch.uspto.gov/search/search-information) (last accessed Sept. 9, 2024).

<sup>89</sup> JUSTIA, "Trademarks." Available at [trademarks.justia.com/](https://trademarks.justia.com/) (last accessed Sept. 9, 2024).

<sup>90</sup> Because the projected price of standards-compliant equipment is typically higher than the price of baseline equipment, using the same markup for the incremental cost and the baseline cost would

DOE developed baseline and incremental markups for wholesalers and contractors using U.S. Census Bureau data from the “2017 Annual Wholesale Trade Report” and the 2017 U.S. Economic Census, respectively.

Chapter 6 of the final rule TSD provides details on DOE’s development of markups for CRE.

#### E. Energy Use Analysis

The purpose of the energy use analysis is to determine the annual energy consumption of CRE at different efficiencies in representative U.S. commercial buildings, and to assess the energy savings potential of increased CRE efficiency. The energy use analysis estimates the range of energy use of CRE in the field (*i.e.*, as they are actually used by consumers). The energy use analysis provides the basis for other analyses DOE performed, particularly assessments of the energy savings and the savings in consumer operating costs that could result from adoption of new or amended standards.

For the October 2023 NOPR, DOE calculated CRE energy consumption as part of the engineering analysis. 88 FR 70196, 70237. DOE used average single-point energy use values for each design option, as described in the October 2023 NOPR engineering analysis (see chapter 5 of the October 2023 NOPR TSD). These values consider field energy use factors prescribed in the CRE test procedure, such as typical door-opening schedules, ambient conditions, typical food and beverage loads, *etc.* Also, as discussed in chapter 7 of the October 2023 NOPR TSD, during the analysis for the 2009 final rule for CRE (74 FR 1092 (Jan. 9, 2009)), DOE conducted an energy use analysis for certain remote condensing equipment and concluded that the results agreed reasonably well with those calculated by the energy consumption model used in the engineering analysis.

In response to the October 2023 NOPR, Ravnitzky suggested that DOE should account for uncertainty and variability in the energy consumption of CRE due to factors such as ambient temperature, door openings, defrost cycles, load patterns, maintenance practices, and user behavior. (Ravnitzky, No. 57 at p. 4) Ravnitzky provided examples of how widely these factors can vary in the field and recommended DOE provide sensitivity analyses or confidence intervals showing the range of possible outcomes under different

result in higher per-unit operating profit. While such an outcome is possible, DOE maintains that in markets that are reasonably competitive it is unlikely that standards would lead to a sustainable increase in profitability in the long run.

scenarios and conditions, using probabilistic methods such as Monte Carlo simulations or Bayesian inference. (*Id.*) NAFEM commented that CRE operate at various conditions, which can be more extreme than the conditions specified by the ASHRAE 72 test conditions, on which DOE is basing its analysis. (NAFEM, No. 83 at p. 24) Similarly, Continental stated that testing CRE at 75 °F/55-percent RH does not accurately represent average real-world conditions and, as a result, the energy consumption levels evaluated for this rulemaking do not reflect actual usage conditions for this equipment. (Continental, No. 86 at p. 3) ITW commented that ambient temperature, humidity, and door-opening frequency and durations in the field differ from the CRE test procedure. (ITW, No. 82 at p. 6) Specifically, regarding door-opening frequency, ITW suggested that, based on data from a quick-service restaurant kitchen, a reach-in refrigerator opens more than 400 times per day for more than 50 seconds per opening and a freezer opens about 500 times per day for more than 20 seconds per opening. (*Id.*) ITW added that such conditions would require more electricity use in the field than what would be required by the proposed standard. (*Id.*)

In response to the August 2024 NODA, Continental restated that using test procedure ambient conditions of 75 °F/55 percent RH does not reflect real-world ambient conditions, leading to a flawed energy use analysis and corresponding standard levels. (Continental, No. 107 at p. 2)

For this final rule, DOE calculated CRE energy consumption as part of the engineering analysis, which estimates the daily energy consumption in kWh/day at each analyzed efficiency level at the representative equipment volumes or TDAs for each equipment class (see chapter 5 of the final rule TSD). DOE calculated the annual energy consumption by multiplying the daily energy consumption by the number of days in a year. With respect to the comments regarding the variability in the energy consumption of CRE, DOE acknowledges that using a single-point estimate to characterize the energy use of each efficiency level in each equipment class may not capture the wide range of ways CRE are used in the field and the varying conditions at which CRE operate (*e.g.*, ambient temperature and humidity; door opening time and frequency; amount, temperature and distribution of food products inside CRE). DOE has the technical capability to include a distribution of values weighted by different factors, including the

aforementioned environmental conditions and user behaviors; however, DOE does not have either data or information with enough detail from which to construct a meaningful distribution to accurately and properly characterize both the variability of the aforementioned factors and the effect those factors may have on the energy use of each analyzed equipment class. For example, DOE does not have data on how door opening frequency and duration vary among purchasers and their associated effect on CRE energy consumption in the field. DOE notes that it also considered typical CRE behavior practices in this analysis, such as the replacement of lighting fixtures, a typical maintenance practice considered also in the March 2014 Final rule. In addition, DOE accounted for typical user behavior in CRE lifetime estimates, which are driven primarily from store renovations. DOE notes that it accounts for uncertainty and variability in the LCC analysis by using a CRE purchaser sample based on the EIA 2018 Commercial Buildings Energy Consumption Survey (“2018 CBECS”),<sup>91</sup> which allows for regional variations in electricity prices and sales tax, and incorporating uncertainty into other parameters, such as discount rates. Additionally, DOE emphasizes that its energy usage analysis adopts a conservative approach in cases where purchaser’s door-opening frequency, ambient temperatures, or food and beverage thermal loads surpass those assumed in the CRE test procedure. This is because increased energy consumption would typically result in increased operating cost savings for higher efficiency equipment compared to CRE at baseline.

In response to the October 2023 NOPR, NAFEM commented that its members report that night curtains are often viewed as an unwanted “accessory” by their customers and, even if purchased, are not consistently used. (NAFEM, No. 83 at p. 7) NAFEM also stated that internal testing performed to DOE guidelines of night curtains being drawn for 6 hours resulted in only a 12-percent reduction of energy usage over a 24-hour period. (*Id.*) Additionally, SCC commented that stores open 24 hrs/day are not suitable for night curtains. (SCC, No. 74 at p. 2)

DOE notes that the current energy use assumptions for night curtains are based on the CRE test procedure, which

<sup>91</sup> U.S. Department of Energy—Energy Information Administration. “2018 Commercial Buildings Energy Consumption Survey (CBECS).” 2018. Available at [www.eia.gov/consumption/commercial/data/2018/](http://www.eia.gov/consumption/commercial/data/2018/) (last accessed Sept. 9, 2024).



assumes that night curtains are used for 6 hours per day (“hrs/day”) and attributes less than a 12 percent energy use reduction associated with this design option. Furthermore, DOE acknowledges that night curtains may not be consistently used across CRE purchasers, whether due to staff behavior or store business hours, but DOE is not aware of data on the distribution of average daily usage of night curtains that could serve as an alternative to the assumption used in the test procedure, which uses a single-point estimate. DOE also clarifies that night curtain daily operating hours in the field may vary from zero hrs/day, for establishments continuously open to the public, to 24 hrs/day, for establishments that close certain days of the week.

In response to the October 2023 NOPR, as discussed in section IV.C.1.b of this document, several commenters stated that occupancy sensors are not a desired feature by most purchasers of CRE because consumers may perceive CRE with deactivated lighting (when LED occupancy sensors are not activated) as malfunctioning and, therefore, they may not use this feature. (NAFEM, No. 83 at p. 6; Zero Zone, No. 75 at p. 4; Hillphoenix, No. 77 at p. 6; Hussmann, No. 80 at pp. 5–6; AHRI, No. 81 at p. 10)

In response to these comments, DOE performed additional research but found no data on field usage patterns of occupancy sensors. DOE acknowledges that some consumers may select to deactivate CRE occupancy sensors and thus forgo energy savings associated with this design option. Accordingly, for the August 2024 NODA, DOE updated its energy use analysis for CRE at efficiency levels with occupancy sensors so that the benefit of an occupancy sensor is applied to only 75 percent of purchasers of this feature.<sup>92</sup> *Id.* In the August 2024 NODA, DOE also requested comments, data, and information on the fraction of CRE purchasers that may choose to deactivate their CRE occupancy sensors. *Id.*

In response to the August 2024 NODA, Hillphoenix, Continental, and Zero Zone commented that CRE end-users may believe the equipment to be malfunctioning if the equipment lights are off. (Hillphoenix, No. 110 at p. 8; Continental, No. 107 at p. 2; Zero Zone,

No. 114 at p. 2) Hillphoenix added that, for this reason, open case CRE are not sold with lighting occupancy sensors to food retail buildings, such as supermarkets, while Continental stated that lighting occupancy sensors are not viable for food service buildings, such as busy commercial kitchens. (Hillphoenix, No. 110 at p. 8; Continental, No. 107 at p. 2) AHRI commented that its members are unable to determine the fraction of CRE purchasers that buy and then deactivate lighting occupancy sensors. AHRI suggested that lighting occupancy sensors only save energy in terms of lighting power consumption reduction and not via refrigeration cooling load reduction because the CRE setpoint temperature cannot be changed due to food regulations. (AHRI, No. 104 at p. 7–8) ASAP *et al.* commented that DOE is taking a conservative approach by considering that only 75 percent of consumers benefit from lighting occupancy sensors, noting that manufacturers will be able to utilize occupancy sensors to meet any amended standards because the test procedure does not include any comparable assumption about deactivation and, as a result, will give full credit for occupancy sensors. (ASAP *et al.*, No. 106 at p. 3) ASAP *et al.* also stated that, after the August 2024 NODA updates, VCT.SC.M and VCT.SC.I equipment classes no longer include this design option in the highest cost-effective efficiency level. *Id.*

In response to August 2024 NODA comments, DOE clarifies that its energy use analysis is based on the engineering analysis and the CRE test procedure, which consider that lighting occupancy sensors reduce direct component energy use as well as cabinet heat load for equipment that has lighting inside the refrigerated space (see section 5.1.1 of the final rule TSD for more details). For this final rule, DOE retained the use of 25 percent as a reasonable estimate for the fraction of purchasers of CRE with LED occupancy sensors that choose to deactivate this feature. However, to account for the uncertainty regarding this estimate and its effect on the energy use and LCC analysis, DOE also performed a sensitivity analysis using 50 percent for the fraction of purchasers of CRE with lighting occupancy sensors that choose to deactivate this feature. The results of this analysis show that for the selected TSL (TSL 3), the LCC savings for all equipment classes with occupancy sensors remain positive at both 75 percent and 50 percent usage. See appendix 8D for more details on this sensitivity analysis.

Chapter 7 of the final rule TSD provides details on DOE’s energy use analysis for CRE.

#### *F. Life-Cycle Cost and Payback Period Analysis*

DOE conducted LCC and PBP analyses to evaluate the economic impacts on individual consumers of potential energy conservation standards for CRE. The effect of new or amended energy conservation standards on individual consumers usually involves a reduction in operating cost and an increase in purchase cost. DOE used the following two metrics to measure consumer impacts:

□ The LCC is the total consumer expense of equipment over the life of that equipment, consisting of total installed cost (manufacturer selling price, distribution chain markups, sales tax, and installation costs) plus operating costs (expenses for energy use, maintenance, and repair). To compute the operating costs, DOE discounts future operating costs to the time of purchase and sums them over the lifetime of the equipment.

□ The PBP is the estimated amount of time (in years) it takes consumers to recover the increased purchase cost (including installation) of more-efficient equipment through lower operating costs. DOE calculates the PBP by dividing the change in purchase cost at higher efficiency levels by the change in annual operating cost for the year that amended or new standards are assumed to take effect.

For any given efficiency level, DOE measures the change in LCC relative to the LCC in the no-new-standards case, which reflects the estimated efficiency distribution of CRE in the absence of new or amended energy conservation standards. In contrast, the PBP for a given efficiency level is measured relative to the baseline equipment.

For each considered efficiency level in each equipment class, DOE calculated the LCC and PBP for a nationally representative set of commercial buildings that use CRE. As stated previously, DOE developed commercial buildings samples from the 2018 CBECS. For each sample building, DOE determined the energy consumption for the CRE and the appropriate energy price. By developing a representative sample of buildings, the analysis captured the variability in energy consumption and energy prices associated with the use of CRE.

Inputs to the LCC calculation include the installed cost to the consumer, operating expenses, the lifetime of the equipment, and a discount rate. Inputs to the calculation of total installed cost

<sup>92</sup> DOE selected 25 percent as a reasonable estimation of the fraction of CRE purchasers that may choose to deactivate their occupancy sensors despite purchasing this feature.

include the cost of the equipment—which includes MPCs, manufacturer markups, retailer and distributor markups, and sales taxes—and installation costs. Inputs to the calculation of operating expenses include annual energy consumption, energy prices and price projections, repair and maintenance costs, equipment lifetimes, and discount rates. Inputs to the PBP calculation include the installed cost to the consumer and first year operating expenses. DOE created distributions of values for equipment lifetime, discount rates, and sales taxes, with probabilities attached to each value, to account for their uncertainty and variability.

The computer model DOE uses to calculate the LCC relies on a Monte Carlo simulation, which is a standard analytical technique used in many academic disciplines, to incorporate uncertainty and variability into the analysis. The Monte Carlo simulations sample input values from the

probability distributions and CRE user samples. For this rulemaking, DOE conducted probability analyses by sampling from probability distributions using Python. To calculate the LCC and PBP for CRE, DOE performed 10,000 Monte Carlo simulations for each variable. During a single trial, values are selected from the defined probability distributions for each variable, which enables the estimation of LCC and PBP with uncertainty evaluation. The analytical results include a distribution of 10,000 data points showing the range of LCC savings for a given efficiency level relative to the no-new-standards case efficiency distribution. In performing an iteration of the Monte Carlo simulation for a given purchaser, equipment efficiency is chosen based on its probability. If the chosen equipment efficiency is greater than or equal to the efficiency of the standard level under consideration, the LCC calculation reveals that a consumer is not impacted by the standard level. By accounting for

consumers who already purchase more-efficient equipment, DOE avoids overstating the potential benefits from increasing equipment efficiency.

DOE calculated the LCC and PBP for consumers of CRE as if each were to purchase new equipment in the expected year of required compliance with new and amended standards. New and amended standards would apply to CRE manufactured 4 years after the date on which any new or amended standard is published in the **Federal Register**. 42 U.S.C. 6313(a)(6)(C)(iv)(I) or (C)(iv)(II). Therefore, DOE used 2029 as the first full year of compliance with any new and amended standards for CRE.

Table IV. summarizes the approach and data DOE used to derive inputs to the LCC and PBP calculations. The subsections that follow provide further discussion. Details of the spreadsheet model, and of all the inputs to the LCC and PBP analyses, are contained in chapter 8 of the final rule TSD and its appendices.

**Table IV.18 Summary of Inputs and Methods for the LCC and PBP Analysis\***

Inputs	Source/Method
Equipment Cost	Derived by multiplying MPCs by manufacturer and retailer markups and sales tax, as appropriate. Apply price learning between present (2023) and compliance year (2029) for LED lighting (1.1% average yearly decline) and variable-speed compressor electronics (6.3% average yearly decline), using historical data to derive a price scaling index to project equipment costs for those components.
Installation Cost	Assumed not to change with efficiency level for a given equipment class; therefore, not considered in the LCC and PBP analyses.
Annual Energy Use	Obtained from engineering analysis. Based on the CRE test procedure for each equipment class at each considered efficiency level.
Energy Prices	Electricity: Edison Electric Institute Typical Bills and Average Rates reports. Variability: Regional energy prices across nine census divisions.
Energy Price Trends	Based on <i>AEO2023</i> <sup>93</sup> price projections.
Repair and Maintenance Costs	Material costs derived from the engineering analysis and labor costs derived from RSMeans 2023. Considered replacement of LED lighting, evaporator and condenser fan motors, compressors, and night curtains; assumed LED lighting repair frequency decreases due to the presence of occupancy sensors when in use by purchaser (see section IV.E). <sup>**</sup>
Equipment Lifetime	Average: 10 years for large buildings and 20 years for small buildings. DOE defined small buildings as those less than or equal to 5,000 ft <sup>2</sup> , while large buildings are defined as those greater than 5,000 ft <sup>2</sup> .
Discount Rates	Approach involves identifying all possible debt or asset classes that might be used to purchase the considered equipment or might be affected indirectly. Primary data source was the Federal Reserve Board's Survey of Consumer Finances.
Compliance Year	2029

\* References for the data sources mentioned in this table are provided in the sections following the table or in chapter 8 of the final rule TSD. Energy price trends, equipment lifetimes, and discount rates are not used for the PBP calculation.

\*\* For the 25 percent of purchasers assumed to not utilize the occupancy sensors, the LED lighting repair frequency remains the same as for CRE without occupancy sensors.

<sup>93</sup> For further information, see the "Assumptions to *AEO2023*" report that sets forth the major

assumptions used to generate the projections in the

*AEO2023*. Available at [www.eia.gov/outlooks/aeo/assumptions/](http://www.eia.gov/outlooks/aeo/assumptions/) (last accessed Sept. 9, 2024).



## 1. Equipment Cost

To calculate consumer equipment costs, DOE multiplied the MPCs developed in the engineering analysis by the markups described previously (along with sales taxes). DOE used different markups for baseline equipment and higher-efficiency equipment, because DOE applies an incremental markup to the increase in MSP associated with higher-efficiency equipment.

DOE used a price-learning analysis to account for changes in LED lamp prices that are expected to occur between the time for which DOE has data for lamp prices (2023) and the assumed compliance date of the rulemaking (2029). The price trend was derived from a price learning factor *experience curve* that computes changes in price as a function of cumulative LED lighting lamp shipments. See chapter 8 of the final rule TSD for more details on how price learning for LED lighting was applied.

As discussed in the engineering analysis (see section IV.C of this document), DOE included variable-speed compressors as a technology option for higher efficiency levels in certain self-contained equipment classes. To develop future prices specific to that technology, DOE applied a different price trend to the electronic control board of the variable-speed compressor. DOE estimated that the cost of that control board was 50 percent of the cost of the variable frequency drive (“VFD”) included in the variable speed compressor. DOE used Producer Price Index (“PPI”) data on “semiconductors and related device manufacturing” between 1967 and 2021 to estimate the historic price trend of electronic components in the control.<sup>94</sup> The analysis used an exponential curve to model the data and found that the trend closely matches the data (R-square = 0.99). This suggests prices are dropping around 6 percent per year on average. See chapter 8 of the final rule TSD for further details on this topic.

## 2. Installation Cost

Installation cost includes labor, overhead, and any miscellaneous materials and parts needed to install the equipment. In response to the October 2023 NOPR, several stakeholders commented that increased installation costs would occur for design options with electronic controllers, such as lighting controllers, due to additional

programming time and higher technician skill requirements. (Hillphoenix, No. 77 at p. 6; FMI and NACS, No. 78 at pp. 2–3; Hussmann, No. 80 at p. 8; AHRI, No. 81 at p. 10) FMI and NACS also commented that increasing energy efficiency would lead to increased installation costs due to additional floor space rearrangement needs. (FMI and NACS, No. 78 at p. 3)

Based on these comments, DOE conducted additional research and found no evidence that any of the analyzed design options considered in this final rule require additional installation time, as electronic controls for variable-speed compressors and LED lighting occupancy sensors are typically factory-finished with pre-set configurations that do not require additional setup time by field technicians compared to baseline equipment. DOE also estimated that installation workers may already have the required skills to install the analyzed design options or would adjust their labor rates equally across all efficiency levels if the necessary skills were lacking. DOE clarifies that CRE external dimensions do not vary by efficiency level within each equipment class. Therefore, in this final rule, as in the October 2023 NOPR, DOE assumed that installation costs do not vary by efficiency level (within the same equipment class), and DOE did not account for installation costs in the LCC and PBP analyses.

For further information on installation costs, see chapter 8 of the final rule TSD.

## 3. Annual Energy Consumption

For each sampled equipment class, DOE determined the energy consumption for CRE at different efficiency levels using the approach described previously in section IV.E of this document.

## 4. Energy Prices

Because marginal electricity price more accurately captures the incremental savings associated with a change in energy use from higher efficiency, it provides a better representation of incremental change in consumer costs than average electricity prices. Therefore, DOE applied average electricity prices for the energy use of the equipment purchased in the no-new-standards case, and marginal electricity prices for the incremental change in energy use associated with the other efficiency levels considered.

DOE derived electricity prices in 2023 using data from Edison Electric Institute (“EEI”) Typical Bills and Average Rates reports. Based upon comprehensive,

industry-wide surveys, this semi-annual report presents typical monthly electric bills and average kilowatt-hour costs to the customer as charged by investor-owned utilities. For the commercial sector, DOE calculated electricity prices using the methodology described in Coughlin and Beraki (2019).<sup>95</sup>

To estimate energy prices in future years, DOE multiplied the 2023 energy prices by the projection of annual average price changes for each of the nine census divisions from the Reference case in *AEO2023*, which has an end year of 2050.<sup>96</sup> To estimate price trends after 2050, the 2046–2050 average was used for all years.

DOE’s methodology allows electricity prices to vary by sector, region, and season. In the analysis, variability in electricity prices is chosen to be consistent with the way the consumer economic and energy use characteristics are defined in the LCC analysis. For CRE, DOE calculated weighted-average values for average and marginal price for the nine census divisions for the commercial sector for both large-size (greater than 5,000 ft<sup>2</sup>) and small-size (less than 5,000 ft<sup>2</sup>) buildings. As the EEI data are published separately for summer and winter, DOE calculated seasonal prices for each division and sector. Each EEI utility in a given region was assigned a weight based on the number of consumers it serves. DOE adjusted these regional weighted-average prices to account for systematic differences between IOUs and publicly owned utilities, as the latter are not included in the EEI data set. See chapter 8 of the final rule TSD for details.

## 5. Maintenance and Repair Costs

Repair costs are associated with repairing or replacing equipment components that have failed; maintenance costs are associated with maintaining the operation of the equipment. Typically, small incremental increases in equipment efficiency entail no, or only minor, changes in repair and maintenance costs compared to baseline efficiency equipment.

In the October 2023 NOPR, DOE calculated repair costs by considering the typical failure rate of refrigeration system components (compressor, lighting, and evaporator and condenser

<sup>95</sup> Coughlin, K. and B. Beraki. 2019. Non-residential Electricity Prices: A Review of Data Sources and Estimation Methods. Lawrence Berkeley National Lab. Berkeley, CA. Report No. LBNL-2001203. Available at [ees.lbl.gov/publications/non-residential-electricity-prices](https://ees.lbl.gov/publications/non-residential-electricity-prices) (last accessed Sept. 9, 2024).

<sup>96</sup> EIA. *Annual Energy Outlook 2023*. Available at [www.eia.gov/outlooks/aeo/](https://www.eia.gov/outlooks/aeo/) (last accessed Sept. 9, 2024).

<sup>94</sup> Semiconductors and related device manufacturing PPI series ID: PCU334413334413; available at [www.bls.gov/ppi/](https://www.bls.gov/ppi/) (last accessed Sept. 9, 2024).

fan motors), component MPCs and associated markups, and the labor cost of repairs, which is assumed to be performed by private vendors. 88 FR 70196, 70239. DOE considered the following specific CRE components and associated failure probabilities during typical CRE lifetime in its repair cost approach: compressor (25 percent), evaporator fan motor (50 percent), condenser fan motor (25 percent), and LED lighting (100 percent), with the presence of occupancy sensors decreasing LED lighting repair frequency by half. *Id.*

In response to the October 2023 NOPR, Hussmann and NAFEM commented that EEVs, lighting controllers, and anti-sweat energy controllers require ongoing maintenance and servicing throughout the equipment lifespan. (Hussmann, No. 80 at p. 8; NAFEM, No. 83 at pp. 5, 7, 21, 22) AHRI also stated that the programming of these components requires higher technician skill and that variable-speed compressors, variable-speed condenser and evaporator fan motors, three pane glass for medium temperature reach-in cases can lead to higher maintenance and repair costs. (AHRI, No. 81 at pp. 5, 10) AHRI and Hussmann expressed concern regarding the use of technologies in CRE applications that do not have an established lifetime estimation, such as variable-speed compressors. (AHRI, No. 81 at p. 10; Hussmann, No. 80 at p. 9) Hoshizaki also indicated that variable-speed compressors could have lower lifespans than single-speed compressors. (Hoshizaki, No. 76 at p. 5) NAFEM commented that leak detection is required for some refrigerants, such as A2L and R-290, and impact maintenance and repair costs, that technicians would replace rather than repair electronic controllers in case of failure, that increasing the number of components in CRE leads to higher failure probability, and that CRE repair downtime would increase for equipment with electronic controls. (NAFEM, No. 83 at pp. 21–22) Hoshizaki stated that incorrect defrost settings could result in increased maintenance costs due to the frequency of door-opening in real-world conditions. (Hoshizaki, No. 76 at p. 5) Additionally, Hoshizaki stated a similar possibility for fan motors compared to less efficient components. (*Id.*) NAMA commented that DOE underestimated repair and maintenance costs. (NAMA, No. 85 at p. 31)

In response to these comments, DOE clarifies that EEVs and anti-sweat energy controllers are not design options considered in this final rule,

that refrigerant type does not vary by efficiency level within each equipment class, and that only repair and maintenance costs that vary by CRE efficiency level are included in the LCC and PBP analyses. DOE also clarifies that the energy use analysis assumes CRE to be in operation continuously (24 hrs/day, 365 days per year). Therefore, DOE does not consider energy savings resulting from downtime for CRE repairs or any other related operational impacts, as they would have a negligible impact in the LCC and PBP analyses. Regarding concerns on the lifetime of variable-speed compressors, DOE notes that this technology option has been available in the CRE market for over a decade. DOE is also not aware of data differentiating compressor and fan motor lifetime by efficiency level or technology type. DOE did not find data suggesting that LED lighting occupancy sensors require ongoing maintenance. As stated in section IV.F.2 of this document, DOE estimates that technician workers may already have the required skills to maintain the analyzed design options or would adjust their labor rates equally across all efficiency levels if the necessary skills were lacking. Therefore, as in the October 2023 NOPR, DOE assumed that maintenance costs do not vary by efficiency level (within the same equipment class), and DOE did not account for maintenance costs in the LCC and PBP analyses in this final rule.

In response to the October 2023 NOPR, regarding the use of night curtains in CRE, DOE received comments from Zero Zone, Hillphoenix, Hussmann, NAFEM, and AHRI stating that these devices incur associated operating expenses, maintenance costs, and need to be replaced before the end of the CRE lifetime. (Zero Zone, No. 75 at p. 4; Hillphoenix, No. 77 at p. 5; Hussmann, No. 80 at p. 8; NAFEM, No. 83 at p. 7; AHRI, No. 81 at p. 10) Zero Zone stated that it contacted a major national store chain that purchases night curtains, who indicated the maximum lifespan to be 3 years but estimated an average lifetime of 18 months. (Zero Zone, No. 75 at p. 4) AHRI stated that night curtains have a 3-year lifetime. (AHRI, No. 81 at p. 10) NAFEM commented that night curtains tend to wear out within 1–2 years, requiring additional maintenance or repair during the lifetime of the CRE. (NAFEM, No. 83 at p. 7) Hillphoenix commented that night curtains are not typically ordered by customers due to their shorter lifespan and the additional costs of installation, maintenance, and operating expense due to the labor or

power to close the curtains each night. (Hillphoenix, No. 77 at p. 5)

In response to the August 2024 NODA, Hillphoenix commented that CRE night curtains can lead to increased repair and maintenance costs as they contribute to short cycling of the compressor, refrigerant oil logging, or, at worse, liquid slugging of the compressor, and increased stress on start components of fixed speed compressor units on self-contained models. (Hillphoenix, No. 110 at p. 10) The CA IOUs commented that they agree with DOE's approach of considering night curtain replacement before the end of CRE lifetime. (CA IOUs, No. 113 at p. 2) Zero Zone stated that the life expectancy of night curtains can be 1 to 3 years. (Zero Zone, No. 114 at p. 2)

In light of the comments received, DOE reviewed data on night curtain lifespans, operational expenses, maintenance, and repair costs, assessing their potential influence on the analytical results of the LCC and PBP analysis. As stated in the August 2024 NODA, DOE also contacted retailers and manufacturers of night curtains of similar cost to the ones contained in the engineering analysis. 89 FR 68788, 68795–68796. These manufacturers and sellers reported lacking information on night curtain lifespan but stated that the lifetime varies according to user care. *Id.* One manufacturer reported a recent replacement from a unit that lasted 10 years. *Id.*

Regarding the comment by Hillphoenix stating that CRE night curtains could lead to increased repair and maintenance costs, it is unlikely that night curtains would cause short-cycling of the compressor because night curtains offer extra insulation against ambient conditions, which reduces the rate of temperature increase within the refrigerated spaces. This results in shorter on-cycles and longer off-cycles, reducing overall compressor run time and, potentially, wear on CRE components. In terms of the other potential effects mentioned (*i.e.*, liquid slugging of the compressor, refrigerant oil logging, or increased stress on start components of fixed speed compressor units on self-contained models), DOE found no literature or data reporting field use patterns of night curtains and whether the use of night curtains has a positive or negative effect on CRE compressors and components. However, in a DOE report prepared by the National Renewable Energy Laboratory



(“NREL”),<sup>97</sup> a study on the energy performance of grocery stores evaluating the effect of night curtains on 103 open refrigerated cases found positive operation and maintenance savings resulting from the installation of night curtains.

In any case, whether positive or negative, DOE did not account for the potential repair and maintenance impacts associated with the daily operation of night curtains due to the lack of specific data. In light of the NREL report, DOE understands this is a likely conservative approach. DOE also assumed that the daily operation of night curtains may be part of the regular job duty of existing employees. DOE reasonably expects new equipment sold with night curtains to come properly balanced and configured upon installation.

In this final rule, consistent with the August 2024 NODA approach and based on commenter feedback and DOE’s additional research, DOE retained the following assumptions on the repair costs of night curtains. First, DOE used 5 years as a reasonable estimate for the average lifetime of all night curtains. As a result, depending on the lifetime associated with each CRE and the building type it may be installed in, night curtains may be replaced once or several times during the CRE lifetime. Second, DOE assumed a half-hour night curtain replacement labor duration at the same labor rates (according to RSMMeans 2023) as other CRE components assumed to be replaced during the CRE lifetime (e.g., compressors) in the LCC analysis. DOE assigned these labor rates according to each purchaser’s census division to better account for national labor cost variability.

## 6. Equipment Lifetime

For CRE, DOE used a lifetime distribution to characterize the probability equipment will be retired from service at a given age. For the October 2023 NOPR, DOE estimated an average lifetime of 10 years for CRE in large buildings and 20 years for CRE in small buildings, with a maximum lifetime of 40 years for each. 88 FR 70196, 70240. DOE also assumed that the probability function for the annual survival of CRE would take the form of a Weibull distribution. *Id.* A Weibull distribution is a probability distribution commonly used to measure failure rates.<sup>98</sup> In response to the October 2023

NOPR, AHRI and Hussmann agreed with DOE’s CRE lifetime assumptions. (AHRI, No. 81 at p. 10; Hussmann, No. 80 at p. 9) NAMA also agreed with DOE’s lifetime assumptions but stated that they do not accurately reflect the lifetimes of refurbished equipment. (NAMA, No. 85 at p. 32) Storemasters commented that additional CRE modifications could increase equipment complexity and cost, thus potentially reducing CRE lifetime. (Storemasters, No. 68 at p. 1) Hussmann stated that smaller food-retailers use their CRE longer than large food-retailers and that smaller food-retailers may attempt to expand CRE lifetimes through repairs. (Hussmann, No. 80 at p. 9) NAFEM and Hussmann commented that purchasers may attempt to expand CRE lifetimes through repairs. (NAFEM, No. 83 at p. 23; Hussmann, No. 80 at p. 9)

In this final rule, DOE retained the lifetime assumptions from the October 2023 NOPR: the mean lifetime distribution assumption for CRE was assumed to be 10 years for large-size buildings and 20 years for small-size buildings, with a maximum lifetime of 40 years for each.

With respect to the comments regarding the lifetimes of refurbished CRE, DOE clarifies that it does not analyze the energy use of refurbished CRE because such equipment is not subject to new standards. However, DOE accounted for purchasers who sell their CRE to companies that refurbish CRE before the end of the equipment lifetime by assigning a credit equivalent to the residual value of the used equipment at the selling year. See the following section (IV.F.7 of this document) for details on the residual value approach.

See chapter 8 of the final rule TSD for more information on equipment lifetime.

## 7. Residual Value for Refurbished CRE

To model the phenomenon of CRE sold for refurbishment, DOE utilized a residual value for such equipment in the LCC. The residual value represents the remaining dollar value of surviving CRE at the average age of refurbishment. In the October 2023 NOPR, DOE estimated that refurbishments would occur at 5 years for small-size food-service buildings (e.g., restaurants) and 10 years for small-size food-sales and other commercial buildings. 88 FR 70196, 70240. To account for the value of CRE with remaining life to the consumer, the LCC model applies this residual value as a “credit” at the end of the CRE lifetime and discounts it back to the start of the analysis period. *Id.* This credit was applied to a fraction of self-contained CRE, totaling about 10

percent of all CRE in the LCC sample. *Id.*

In response to the October 2023 NOPR, Hussmann commented estimating that remote cases are typically refurbished after 10–12 years of use, while self-contained CRE are refurbished less frequently but sooner, after 7–9 years of use. (Hussmann, No. 80 at p. 9) During the November 2023 Public Meeting, True commented that the CRE manufacturers have little knowledge and data about the refurbishment market but suggested that restaurant chains typically buy new CRE and, after usage, resell them, while, small-business restaurants tend to buy refurbished equipment due to the lower cost associated with refurbished units. (November 2023 Public Meeting Transcript, No. 64 at pp. 126–128) Hussmann also commented that smaller independent retailers are more likely to refurbish their CRE compared to other businesses due to having less capital available to purchase new units. (Hussmann, No. 80 at p. 9) However, NAFEM commented that larger restaurant chains can also buy refurbished equipment when opening a new store and could later replace them with new equipment if the store remains open. (November 2023 Public Meeting Transcript, No. 64 at pp. 128–129) Hillphoenix stated that refurbished equipment are usually 50 percent the cost of new equipment. (Hillphoenix, No. 77 at p. 2)

Following the August 2024 NODA, the CA IOUs commented in support of the NODA analysis update that expanded the self-contained CRE refurbishment market to include all businesses, regardless of size. (CA IOUs, No. 113 at p. 2) Several commenters stated that, in addition to self-contained CRE, remote-condensing CRE are also subject to refurbishments when stores close or undergo remodeling. (AHRI, No. 104 at p. 8; Hillphoenix, No. 110 at p. 11; Hussmann, No. 108 at p. 2)

In response to these comments, DOE acknowledges that remote-condensing CRE may also be subject to refurbishments when stores close or undergo remodeling. However, the refurbishment schedule of remote-condensing CRE is more likely to coincide with the estimated corresponding CRE lifetimes in the LCC analysis. As discussed in the previous section, CRE in large-size buildings (in which remote-condensing CRE are typically installed) are estimated to have a 10-year average lifetime -primarily reflecting store renovations or closures. Therefore, in the LCC analysis, DOE did not account for a refurbishment credit to CRE purchasers. Nonetheless, as

<sup>97</sup> See Advanced Energy Retrofit Guides for Grocery Stores, available at [www.nrel.gov/docs/fy13osti/54243.pdf](http://www.nrel.gov/docs/fy13osti/54243.pdf) (last accessed Sept. 9, 2024).

<sup>98</sup> Weibull distributions are commonly used to model appliance and equipment lifetimes.

discussed in the following section (IV.G of this document), DOE applied price elasticity to all CRE (including remote-condensing units) as part of a sensitivity analysis. The results of this analysis can be found in Appendix 10C of the final rule TSD.

In this final rule, consistent with the August 2024 NODA approach, DOE applied a credit to about 10 percent of all CRE in the sample. This credit may apply to any self-contained equipment regardless of building size, based on the premise that if the refurbishment market offers a favorable economic opportunity, it could be utilized by all businesses, not just businesses in small-size buildings. DOE retained the same assumptions as in the October 2023 NOPR regarding the average CRE lifetimes at the time of refurbishment, occurring after 5 years for food-service buildings (*e.g.*, restaurants) and after 10 years for food-sales, and other building types (*e.g.*, grocery stores).

#### 8. Discount Rates

In the calculation of LCC, DOE applies discount rates appropriate to commercial consumers to estimate the present value of future expenditures and savings.

For purchasers of CRE in the commercial sector, DOE used the cost of capital to estimate the present value of cash flows to be derived from a typical company project or investment. Most companies use both debt and equity capital to fund investments, so the cost of capital is the weighted-average cost to the firm of equity and debt financing. This corporate finance approach is referred to as the weighted-average cost of capital. DOE used currently available economic data in developing commercial discount rates, with Damodaran Online being the primary data source.<sup>99</sup> The weighted-average discount rate for the commercial sector for CRE is 6.4 percent.

See chapter 8 of the final rule TSD for further details on the development of discount rates.

#### 9. Energy Efficiency Distribution in the No-New-Standards Case

To accurately estimate the share of consumers that would be affected by a potential energy conservation standard at a particular efficiency level, DOE's LCC analysis considered the projected distribution (market shares) of equipment efficiencies under the no-new-standards case (*i.e.*, the case without amended or new energy conservation standards) in the compliance year. This approach reflects the fact that some consumers may purchase equipment with efficiencies greater than the baseline levels in the absence of new or amended standards.

To estimate the energy efficiency distribution of CRE for 2029, DOE used test data, feedback from manufacturer interviews, surveys (see Trade Associations Survey, No. 50), and the "Single Compartment Commercial Refrigeration Equipment" data from DOE's CCD, accessed in February 2024.<sup>100</sup>

In response to the October 2023 NOPR, NEEA and NWPCC commented that DOE uses R-290 as the no-new-standards case (*i.e.*, baseline) for self-contained CRE because the proposed standard compliance dates will occur after EPA refrigerant restriction compliance dates that require R-290 or another low-GWP refrigerant. (NEEA and NWPCC, No. 89 at p. 5) NEEA and NWPCC commented that R-290 is expected to improve efficiency compared to current refrigerants because of its higher refrigeration-cycle efficiency over current refrigerants, so accounting for this ensures DOE is not overestimating savings from increased standards. (*Id.*) As discussed in the engineering analysis (section IV.C.1.a.i of this document), DOE assumed that all manufacturers will switch to R-290 for self-contained CRE in response to the December 2022 EPA NOPR. The EPA compliance date is 2025, which is earlier than the expected DOE CRE energy conservation standards compliance date of 2029. This approach reduces the potential maximum energy

savings below the baseline compared to the June 2022 Preliminary Analysis. The October 2023 EPA Final Rule maintained a 2025 compliance date for self-contained CRE. As such, DOE maintains its approach from the October 2023 NOPR for self-contained CRE within the scope of this rulemaking.

To create a robust sample for the energy efficiency distribution used in the LCC analysis, DOE separated the analyzed CRE equipment classes into 20 separate groups. For the equipment classes that DOE relied on CCD model count data to formulate the efficiency distributions, this approach was used to allow equipment classes with a limited sample to share the efficiency distribution of a group of similar classes with a larger sample in the CCD. DOE compared energy use data from the CCD with energy use equations from the engineering analysis to derive model counts at each efficiency level. Equipment classes whose efficiency distributions were derived from aggregated data from manufacturer interviews, surveys, and test data were assigned their own groups. The estimated market shares for the no-new-standards case for CRE and the corresponding groupings are shown in table IV.. See chapter 8 of the final rule TSD for further information on the derivation of the efficiency distributions.

In advance of the October 2023 NOPR, DOE conducted manufacturer interviews and collected shipments data for several equipment classes. 88 FR 70196, 70241. The equipment classes for which data was collected account for 75 percent of total shipments and are marked with an asterisk in table IV.<sup>101</sup> *Id.* For the remainder of the equipment classes for which DOE was not able to collect representative shipments data from manufacturers due to low sample sizes, DOE utilized the CCD database to estimate the no-new-standards-case efficiency distribution. *Id.* DOE followed this same approach for this final rule.

<sup>99</sup> Damodaran, A. Data: Cost of Capital by Industry Sector, United States. 2023. Available at [pages.stern.nyu.edu/~adamodar/](https://pages.stern.nyu.edu/~adamodar/) (last accessed Sept. 9, 2024).

<sup>100</sup> U.S. Department of Energy. Compliance Certification Database ("CCD") for Refrigeration Equipment—Commercial, Single Compartment. Available at [www.regulations.doe.gov/certification-data/](https://www.regulations.doe.gov/certification-data/) (last accessed February. 9, 2024).

<sup>101</sup> For some of these classes, such as chef bases or griddle stands and high-temperature refrigerators, DOE also developed the efficiency distributions based on DOE's test data, data submitted by manufacturers, ENERGY STAR certified data, and data from DOE's CCD.



**Table IV.19 No-New-Standards Case Efficiency Distributions in 2029**

Equipment Class**	Group	Market Share by Efficiency Level***							
		EL 0	EL 1	EL 2	EL 3	EL 4	EL 5	EL 6	EL 7
VOP.RC.M	1	36%	11%	53%					
VOP.RC.L	1	36%	11%	53%					
VOP.SC.M*	2	90%	0%	2%	4%	1%	4%		
VCT.RC.M	3	9%	35%	5%	8%	43%			
VCT.RC.L	3	15%	61%	9%	15%				
VCT.SC.H*	4	27%	14%	14%	0%	9%	9%	0%	27%
VCT.SC.M*	5	43%	16%	1%	1%	0%	1%	39%	
VCT.SC.L*	6	40%	50%	0%	0%	0%	10%		
VCT.SC.I	7	2%	10%	37%	52%				
VCS.SC.H*	8	0%	25%	50%	25%				
VCS.SC.M*	9	45%	26%	30%					
VCS.SC.L*	10	52%	0%	44%	4%				
VCS.SC.I	10	8%	7%	53%	32%				
SVO.RC.M	11	58%	12%	31%					
SVO.SC.M	12	51%	5%	3%	8%	2%	30%		
SOC.RC.M	13	12%	50%	0%	1%	37%			
SOC.SC.M	14	41%	2%	1%	5%	0%	7%	0%	44%
HZO.RC.M	15	100%							
HZO.RC.L	15	100%							
HZO.SC.M	16	7%	48%	45%					
HZO.SC.L	16	7%	48%	45%					
HCT.SC.M	17	43%	6%	35%	1%	2%	13%		
HCT.SC.L	17	26%	3%	21%	1%	1%	8%	40%	
HCT.SC.I	17	26%	3%	21%	1%	1%	8%	40%	
HCS.SC.M	18	24%	35%	41%					
HCS.SC.L	18	40%	60%						
CB.SC.M*	19	23%	0%	23%	54%				
CB.SC.L*	20	31%	15%	15%	38%				

\* The distributions for these equipment classes were derived from aggregated data from the Trade Associations Survey, test data, and manufacturer interview data.

\*\* Certain equipment classes have large percentages of shipments at both baseline and at max tech; these distributions are due to variability in equipment design across the market.

\*\*\* The sum of certain equipment classes may not equal 100 percent due to rounding.

The LCC Monte Carlo simulations draw from the efficiency distributions and assign an efficiency to the CRE purchased by each sample consumer in the no-new-standards case. The resulting percent shares within the sample match the market shares in the efficiency distributions. For further details on probability analysis and Monte Carlo simulation, see appendix 8B of the final rule TSD.

While DOE acknowledges that economic factors may play a role when consumers purchase CRE, assignment of CRE efficiency for a given installation based solely on economic measures, such as life-cycle cost or simple payback period, most likely would not fully and accurately reflect actual real-world installations. There are a number of market failures discussed in the economics literature that illustrate how purchasing decisions in the commercial

sector with respect to energy efficiency are unlikely to be perfectly correlated with energy use. One study in particular showed evidence of substantial gains in energy efficiency that could have been achieved without negative repercussions on profitability, but the investments had not been undertaken by firms.<sup>102</sup> The study found that multiple

<sup>102</sup> DeCanio, S. J. (1998). "The Efficiency Paradox: Bureaucratic and Organizational Barriers to

organizational and institutional factors caused firms to require shorter payback periods and higher returns than the cost of capital for alternative investments of similar risk. A number of other case studies similarly demonstrate the existence of market failures preventing the adoption of energy-efficient technologies in a variety of commercial sectors around the world, including office buildings,<sup>103</sup> supermarkets,<sup>104</sup> and the electric motor market.<sup>105</sup>

While this literature is not specific to CRE, DOE finds that the method of assignment simulates behavior in the CRE market, where market failures and other consumer preferences result in purchasing decisions not being perfectly aligned with economic interests, more realistically than relying only on apparent cost-effectiveness criteria derived from the limited information in CBECS.<sup>106</sup> DOE further emphasizes that its approach does not assume that all purchasers of CRE make economically irrational decisions (*i.e.*, the lack of a correlation is not the same as a negative correlation). As part of the sample assignment, some buildings with high refrigeration load will be assigned higher efficiency CRE, and some buildings with particularly low refrigeration energy use will be assigned baseline CRE. By using this approach, DOE acknowledges the variety of market failures and other consumer behaviors present in the CRE market, and does not assume certain market conditions unsupported by the available evidence.

First, consumers are motivated by more than simple financial trade-offs. There are consumers who are willing to pay a premium for more energy-efficient equipment because they are

environmentally conscious.<sup>107</sup> There are also several behavioral factors that can influence the purchasing decisions of complicated multi-attribute products, such as CRE. For example, consumers (or decision makers in an organization) are highly influenced by choice architecture, defined as the framing of the decision, the surrounding circumstances of the purchase, the alternatives available, and how they're presented for any given choice scenario.<sup>108</sup> The same consumer or decision maker may make different choices depending on the characteristics of the decision context (*e.g.*, the timing of the purchase, competing demands for funds), which have nothing to do with the characteristics of the alternatives themselves or their prices. Consumers or decision makers also face a variety of other behavioral phenomena including loss aversion, sensitivity to information salience, and other forms of bounded rationality.<sup>109</sup> R.H. Thaler, who won the Nobel Prize in Economics in 2017 for his contributions to behavioral economics, and Sunstein point out that these behavioral factors are strongest when the decisions are complex and infrequent, when feedback on the decision is muted and slow, and when there is a high degree of information asymmetry.<sup>110</sup> These characteristics describe almost all purchasing situations of appliances and equipment, including CRE. The installation of a new or replacement CRE is done infrequently, as evidenced by their mean lifetime. Further, if the purchaser of the CRE is not the entity paying the energy costs (*e.g.*, a building owner and tenant), there may be little to no feedback on the purchase.

#### 10. Payback Period Analysis

The PBP is the amount of time (expressed in years) it takes the consumer to recover the additional

installed cost of more-efficient equipment, compared to baseline equipment, through energy cost savings. PBPs that exceed the life of the equipment mean that the increased total installed cost is not recovered in reduced operating expenses.

The inputs to the PBP calculation for each efficiency level are the change in total installed cost of the equipment and the change in the first-year annual operating expenditures relative to the baseline. DOE refers to this as a "simple PBP" because it does not consider changes over time in operating cost savings. The PBP calculation uses the same inputs as the LCC analysis when deriving first-year operating costs.

As noted previously, EPCA establishes a rebuttable presumption that a standard is economically justified if the Secretary finds that the additional cost to the consumer of purchasing equipment complying with an energy conservation standard level will be less than three times the value of the first year's energy savings resulting from the standard, as calculated under the applicable test procedure. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(iii)) For each considered efficiency level, DOE determined the value of the first year's energy savings by calculating the energy savings in accordance with the applicable DOE test procedure, and multiplying those savings by the average energy price projection for the year in which compliance with the new and amended standards would be required.

In response to the October 2023 NOPR, Hussmann commented that retailers purchasing equipment will not consider PBPs greater than 3 years for design options and prefer payback periods under 2 years. (Hussmann, No. 80 at p. 8) Hussmann further commented that DOE's payback periods at the proposed standard levels for many of the equipment classes are above the rebuttable presumption threshold of 3 years according to EPCA. (*Id.*) In response to the October 2023 NOPR, Hillphoenix commented that the reported payback periods are beyond the industry standard of 2–3 years. (Hillphoenix, No. 77 at p. 5) Hillphoenix added that these increased costs will be passed onto consumers, and particularly low-income consumers, by citing a 2023 study by the U.S. Government Accountability Office ("GAO")<sup>111</sup> (*Id.* at pp. 5–6) NAFEM commented that many payback periods are longer than the equipment lifetime; thus, consumers will never enjoy the economic benefit of the more expensive

Profitable Energy-Saving Investments," *Energy Policy*, 26(5), 441–454.

<sup>103</sup> Prindle 2007, *op. cit.* Howarth, R.B., Haddad, B.M., and Paton, B. (2000). "The economics of energy efficiency: insights from voluntary participation programs," *Energy Policy*, 28, 477–486.

<sup>104</sup> Klemick, H., Kopits, E., Wolverton, A. (2017). "Potential Barriers to Improving Energy Efficiency in Commercial Buildings: The Case of Supermarket Refrigeration," *Journal of Benefit-Cost Analysis*, 8(1), 115–145.

<sup>105</sup> de Almeida, E.L.F. (1998), "Energy efficiency and the limits of market forces: The example of the electric motor market in France," *Energy Policy*, 26(8), 643–653.

Xenergy, Inc. (1998), United States Industrial Electric Motor Systems Market Opportunity Assessment. Available at [www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf](http://www.energy.gov/sites/default/files/2014/04/f15/mtrmkt.pdf) (last accessed Sept. 9, 2024).

<sup>106</sup> CBECS identifies CRE in each representative building (and further breaks down to 'open' and 'closed' refrigeration cases in each building with CRE). Also, as discussed in section IV.F.6, building size and category (*i.e.*, food sales, food service, or other building categories) are correlated with CRE lifetimes, which are sampled using probability distributions.

<sup>107</sup> Ward, D. O., Clark, C. D., Jensen, K. L., Yen, S. T., & Russell, C. S. (2011): "Factors influencing willingness-to pay for the ENERGY STAR® label," *Energy Policy*, 39(3), 1450–1458. (Available at: [www.sciencedirect.com/science/article/abs/pii/S0301421510009171](http://www.sciencedirect.com/science/article/abs/pii/S0301421510009171)) (Last accessed January 5, 2024).

<sup>108</sup> Thaler, R.H., Sunstein, C.R., and Balz, J.P. (2014). "Choice Architecture" in *The Behavioral Foundations of Public Policy*, Eldar Shafir (ed).

<sup>109</sup> Thaler, R.H., and Bernartzi, S. (2004). "Save More Tomorrow: Using Behavioral Economics to Increase Employee Savings," *Journal of Political Economy* 112(1), S164–S187. See also Klemick, H., et al. (2015) "Heavy-Duty Trucking and the Energy Efficiency Paradox: Evidence from Focus Groups and Interviews," *Transportation Research Part A: Policy & Practice*, 77, 154–166. (providing evidence that loss aversion and other market failures can affect otherwise profit-maximizing firms).

<sup>110</sup> Thaler, R.H., and Sunstein, C.R. (2008). *Nudge: Improving Decisions on Health, Wealth, and Happiness*. New Haven, CT: Yale University Press.

<sup>111</sup> Available at [www.gao.gov/assets/gao-23/105846.pdf](http://www.gao.gov/assets/gao-23/105846.pdf) (last accessed Sept. 9, 2024).



CRE. (NAFEM, No. 83 at p. 17) NAFEM suggested that PBPs above 3–7.6 years will cause consumers to turn to cheaper refurbished equipment. (*Id.* at pp. 17–18) In response to the October 2023 NOPR, Zero Zone commented suggesting that DOE should use a maximum payback of 3 years and eliminate any TSLs that exceed 3 years. (Zero Zone, No. 75 at p. 3) Kirby commented that the proposed standards will significantly require excessive payback periods for redesigning equipment and refrigeration. (Kirby, No. 66 at p. 2) In addition, in the November 2023 Public Meeting, Arneg USA commented that, in its experience, customers are not interested in anything with a payback period of more than 3 years. (November 2023 Public Meeting Transcript, No. 64 at pp. 112–113)

In response to the August 2024 NODA, Zero Zone commented that the CRE industry invests in features that have a 1–2 year payback period, thus DOE should include design components that have a relatively shorter payback. (Zero Zone, No. 114 at p. 2) Hillphoenix also commented reiterating their NOPR comment. (Hillphoenix, No. 110 at p. 9)

In response to the comments from Hussmann, Hillphoenix, NAFEM, Zero Zone, and Kirby, and Arneg USA, DOE acknowledges that the estimated payback periods in the October 2023 NOPR are longer than the 2–3 years typically expected for voluntary efficiency upgrades in some equipment classes. However, while DOE strives to propose standards that encourage adoption by industry stakeholders, when deciding whether a proposed standard is economically justified, DOE determines whether the benefits of the standard exceed its burdens by considering the seven statutory factors discussed in section II.A of this document ((1) economic impact; (2) operating cost savings; (3) energy savings; (4) utility impact; (5) competition; (6) the need of the nation to conserve; (7) other factors). DOE considers the seven statutory factors when evaluating a TSL and provides a detailed comparative discussion and rigorous justification on that TSL (see section V.C of this document for a detailed discussion on the adopted TSL for this final rule). DOE notes that, for most of the analyzed equipment classes, the payback period at the selected TSL in the October 2023 NOPR is below the equipment's lifetime, or within the range suggested by NAFEM. In addition, the shipment-weighted average PBP for all equipment classes at the selected TSL (TSL 3) is 3.5 years. Regarding the GAO study cited by Hillphoenix, the report mentions many factors that affect

the food supply chain and can affect retail food prices to consumers but it does not cite the cost increase of CRE, or any other grocery store equipment capital cost, as a relevant factor influencing food price inflation. DOE also clarifies that, according to 42 U.S.C. 6316(e)(1) and 42 U.S.C. 6295(o)(2)(B)(iii), when the rebuttable presumption criterion is not met, this criterion is not taken into consideration when determining whether a standard is economically justified.

### G. Shipments Analysis

DOE uses projections of annual equipment shipments to calculate the national impacts of potential amended or new energy conservation standards on energy use, NPV, and future manufacturer cash flows.<sup>112</sup> The shipments model takes an accounting approach, tracking market shares of each equipment class and the vintage of units in the stock. Stock accounting uses equipment shipments as inputs to estimate the age distribution of in-service equipment stocks for all years. The age distribution of in-service equipment stocks is a key input to calculations of both the NES and NPV, because operating costs for any year depend on the age distribution of the stock.

For the shipments analysis conducted for this final rule, DOE followed the same approach as the October 2023 NOPR, with the exception of CRE that may be subject to refurbishment, as discussed in the following paragraphs.

DOE categorized CRE based on the building types in which they are used as food sales, food service, and all other building types, according to the 2018 CBECS, as discussed earlier in this document. DOE also used the 2018 CBECS to further differentiate CRE into open and closed refrigeration units. DOE estimates demand for these equipment categories by calculating demand coming from new construction as well as the replacement of retiring units for each year.

To calculate new demand for CRE in each category, DOE combined new and existing floorspace projections from *AEO2023* with saturation estimates based on 2018 CBECS and *AEO2023*. DOE also collected shipments data during manufacturer interviews and re-estimated the market shares for each equipment class based on the collected data. DOE scaled the shipment and stock estimates from the floorspace and

saturation calculations to the data obtained from manufacturers for the year 2022. DOE notes that, due to lack of shipments data for some equipment classes with a small market share, DOE estimated their shipments based on other equipment classes with similar characteristics for those equipment classes. For example, in this final rule, DOE assumed that shipments of VCT.SC.H are 1 percent of VCT.SC.I and that shipments for HZO.SC.M are equivalent to HZO.SC.L. More information on these assumptions can be found in chapter 9 of the final rule TSD. DOE also compared its shipments data with numbers reported by ENERGY STAR in its unit shipment and market penetration report for the calendar year 2022.<sup>113</sup> DOE's shipment results are generally consistent with the figures provided by ENERGY STAR, which reported 50-percent market penetration for the reported year. Shipments for CRE categories in each application are then disaggregated across the analyzed CRE classes, using fixed market shares derived from data collected during manufacturer interviews.

Historically, the annual amount of CRE capacity shipped has been depicted in linear feet, which is also an alternative way to express shipments data. The linear feet shipped for any given year can be found by multiplying each unit shipped by its associated average length and then summing all the linear footage values. Chapter 9 of the final rule TSD presents the representative equipment-class lengths used for the conversion of per-unit shipments to linear footage within each equipment class.

To compute demand for replacements, DOE used the lifetime distributions determined in the LCC analysis, which estimates an average lifetime of 10 years for large grocery/multi-line stores (food-sales buildings) and restaurants (food-service buildings), and an average lifetime of 20 years for small food-sales and food-service buildings, with a maximum lifetime of 40 years for all equipment. In each analysis year of the model, DOE calculated retirements across the distribution to compute all demand arising from the retirements.

In response to the October 2023 NOPR, several stakeholders provided comments related to CRE

<sup>112</sup> DOE uses data on manufacturer shipments as a proxy for national sales, as aggregate data on sales are lacking. In general, one would expect a close correspondence between shipments and sales.

<sup>113</sup> ENERGY STAR®. ENERGY STAR Unit Shipment and Market Penetration Report Calendar Year 2022 Summary. 2023. U.S. Environmental Protection Agency and U.S. Department of Energy. Available at [www.energystar.gov/sites/default/files/2022%20Unit%20Shipment%20Data%20Summary%20Report.pdf](http://www.energystar.gov/sites/default/files/2022%20Unit%20Shipment%20Data%20Summary%20Report.pdf) (last accessed July 29, 2024).