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[6450-01-P]

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 **INSERT DATE 60 DAYS AFTER DATE OF PUBLICATION IN THE *FEDERAL REGISTER***. Compliance with the new and amended standards established for commercial refrigerators, freezers, and refrigerator-freezers in this final rule is required on and after [**INSERT DATE 4 YEARS AFTER DATE OF PUBLICTION IN THE *FEDERAL REGISTER***].

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*. All documents in the docket are listed in the *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 webpage can be found at *www.regulations.gov/docket/EERE-2017-BT-STD-0007*. The docket webpage 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*.

FOR FURTHER INFORMATION CONTACT:

Mr. Jeremy Dommu, U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, Building Technologies Office, EE-5B, 1000 Independence Avenue SW, Washington, DC, 20585-0121. Telephone: (202) 586-9870. Email: *ApplianceStandardsQuestions@ee.doe.gov*.

Ms. Kristin Koernig, U.S. Department of Energy, Office of the General Counsel, GC-33, 1000 Independence Avenue SW, Washington, DC, 20585-0121. Telephone: (202) 586-4798. Email: *Kristin.Koernig@hq.doe.gov.*

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I. Synopsis of the Final Rule

EPCA, Pub. L. 94-163, as amended,[1] 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,[2] added by Pub. L. 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 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

[1] All references to EPCA in this document refer to the statute as amended through the Energy Act of 2020, Pub. L. 116-260 (Dec. 27, 2020), which reflects the last statutory amendments that impact Parts A and A-1 of EPCA.
[2] For editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A-1.

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 section 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.

Table I.1 Energy Conservation Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers (Compliance Starting INSERT DATE/2029)

Equipment Class	Capacity Range	Maximum Daily Energy Consumption *kWh/day**
VOP.RC.H	All TDAs are applicable	0.551 × TDA + 3.506
VOP.RC.M	All TDAs are applicable	0.591 × TDA + 3.758
VOP.RC.L	All TDAs are applicable	2.079 × TDA + 6.472
VOP.RC.I	All TDAs are applicable	2.637 × TDA + 8.222
SVO.RC.H	All TDAs are applicable	0.572 × TDA + 2.756
SVO.RC.M	All TDAs are applicable	0.611 × TDA + 2.944
SVO.RC.L	All TDAs are applicable	2.079 × TDA + 6.473
SVO.RC.I	All TDAs are applicable	2.637 × TDA + 8.222

HZO.RC.H	All TDAs are applicable	0.350 × TDA + 2.880
HZO.RC.M	All TDAs are applicable	0.350 × TDA + 2.880
HZO.RC.L	All TDAs are applicable	0.550 × TDA + 6.880
HZO.RC.I	All TDAs are applicable	0.700 × TDA + 8.740
VCT.RC.H	All TDAs are applicable	0.150 × TDA + 1.950
VCT.RC.M	All TDAs are applicable	0.150 × TDA + 1.950
VCT.RC.L	All TDAs are applicable	0.490 × TDA + 2.610
VCT.RC.I	All TDAs are applicable	0.580 × TDA + 3.050
HCT.RC.M	All TDAs are applicable	0.160 × TDA + 0.130
HCT.RC.L	All TDAs are applicable	0.340 × TDA + 0.260
HCT.RC.I	All TDAs are applicable	0.356 × TDA + 0.276
VCS.RC.H	All volumes are applicable	0.100 × V + 0.260
VCS.RC.M	All volumes are applicable	0.100 × V + 0.260
VCS.RC.L	All volumes are applicable	0.210 × V + 0.540
VCS.RC.I	All volumes are applicable	0.250 × V + 0.630
HCS.RC.M	All volumes are applicable	0.100 × V + 0.260
HCS.RC.L	All volumes are applicable	0.210 × V + 0.540
HCS.RC.I	All volumes are applicable	0.250 × V + 0.630
SOC.RC.H	All TDAs are applicable	0.440 × TDA + 0.110
SOC.RC.M	All TDAs are applicable	0.440 × TDA + 0.110
SOC.RC.L	All TDAs are applicable	0.930 × TDA + 0.220
SOC.RC.I	All TDAs are applicable	0.970 × TDA + 0.231
CB.RC.M	All volumes are applicable	0.050 × V + 0.686
CB.RC.L	All volumes are applicable	0.194 × V + 1.693
VOP.SC.H	All TDAs are applicable	0.890 × TDA + 2.480****
VOP.SC.M – Non-Large	TDA ≤ 17	1.230 × TDA + 3.428
VOP.SC.M – Large***	TDA > 17	1.69 × TDA + 4.71
VOP.SC.L	All TDAs are applicable	3.092 × TDA + 8.598
VOP.SC.I	All TDAs are applicable	3.928 × TDA + 10.926
SVO.SC.H	All volumes are applicable	1.045 × TDA + 2.822
SVO.SC.M – Non-Large	TDA ≤ 15	1.207 × TDA + 3.258
SVO.SC.M – Large***	TDA > 15	1.7 × TDA + 4.59
SVO.SC.L	All TDAs are applicable	3.024 × TDA + 8.169
SVO.SC.I	All TDAs are applicable	3.840 × TDA + 10.384
HZO.SC.H	All TDAs are applicable	0.546 × TDA + 4.211
HZO.SC.M	All TDAs are applicable	0.532 × TDA + 4.100

HZO.SC.L – Non-Large	TDA ≤ 35	1.490 × TDA + 5.554
HZO.SC.L – Large***	TDA > 35	1.9 × TDA + 7.08
HZO.SC.I	All TDAs are applicable	1.900 × TDA + 7.065
VCT.SC.H	All volumes are applicable	0.047 × V + 0.493
VCT.SC.M – Non-Large	V ≤ 100	0.073 × V + 0.630
VCT.SC.M with Feature**	V ≤ 100	0.078 × V + 0.674
VCT.SC.M – Large***	V > 100	0.1 × V + 0.86
VCT.SC.L – Non-Large	V ≤ 70	0.233 × V + 2.374
VCT.SC.L with Feature**	V ≤ 70	0.249 × V + 2.540
VCT.SC.L – Large***	V > 70	0.29 × V + 2.95
VCT.SC.I	All TDAs are applicable	0.620 × TDA + 3.290
HCT.SC.M	All volumes are applicable	0.060 × V + 0.370
HCT.SC.L	All volumes are applicable	0.080 × V + 1.230
HCT.SC.I	All TDAs are applicable	0.498 × TDA + 0.383
VCS.SC.H	All volumes are applicable	0.021 × V + 0.793
VCS.SC.M	All volumes are applicable	0.038 × V + 1.039
VCS.SC.M with Feature**	All volumes are applicable	0.041 × V + 1.112
VCS.SC.L – Non-Large	V ≤ 100	0.169 × V + 1.059****
VCS.SC.L with Feature**	V ≤ 100	0.181 × V + 1.133
VCS.SC.L – Large***	V > 100	0.22 × V + 1.38
VCS.SC.I	All volumes are applicable	0.264 × V + 0.683
HCS.SC.M	All volumes are applicable	0.037 × V + 0.675
HCS.SC.L	All volumes are applicable	0.055 × V + 1.033
HCS.SC.L with Feature**	All TDAs are applicable	0.059 × V + 1.105
HCS.SC.I	All volumes are applicable	0.313 × V + 0.811
SOC.SC.H	All TDAs are applicable	0.304 × TDA + 0.584
SOC.SC.M – Non-Large	TDA ≤ 40	0.356 × TDA + 0.685
SOC.SC.M – Large***	TDA > 40	0.52 × TDA + 1.
SOC.SC.L	All TDAs are applicable	1.100 × TDA + 2.100
SOC.SC.I	All TDAs are applicable	1.530 × TDA + 0.360
CB.SC.M	All volumes are applicable	0.081 × V + 1.117
CB.SC.L	All volumes are applicable	0.297 × V + 2.591
PD.SC.M	All volumes are applicable	0.11 × 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^3, as determined in appendix B to subpart C of part 431. TDA is the total display area, expressed in ft^2, 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 (≤ 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 Drawer units
VCS.SC.L (≤ 100)	Pass-through doors Roll-in doors Roll-through doors Drawer units
HCS.SC.L	Forced air evaporator

A. Benefits and Costs to Consumers[3]

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").[4] 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).

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

[3] 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.

[4] 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).

VOP.SC.M	1867.5	1.4

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 (2029–2058) amount to 1.11 quadrillion British thermal units ("Btu"), or quads.[5] 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")[6] of carbon dioxide ("CO_2"), 6.0 thousand tons of sulfur dioxide ("SO_2"), 36.9 thousand tons of nitrogen oxides ("NO_X"), 168 thousand tons of methane ("CH_4"), 0.2 thousand tons of nitrous oxide ("N_2O"), and 0.04 tons of mercury ("Hg").[7]

DOE estimates the value of climate benefits from a reduction in greenhouse gases ("GHG") using different estimates of the social cost of CO_2 ("SC-CO_2"), the social cost of

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[5] 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.

[6] A metric ton is equivalent to 1.1 short tons. Results for emissions other than CO_2 are presented in short tons.

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

methane (“SC-CH_4”), and the social cost of nitrous oxide (“SC-N_2O”). 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.[8] 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 inclusion of the estimated monetized benefits of reduced GHG emissions.

DOE estimated the monetary health benefits of SO_2 and NO_X emissions reductions using benefit-per-ton estimates from the EPA’s Benefits Mapping and Analysis Program [9] as discussed in Section IV.L of this document. DOE did not monetize the change in mercury

[8] *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.* https://www.epa.gov/system/files/documents/2023-12/eo12866_oil-and-gas-nsps-eg-climate-review-2060-av16-final-rule-20231130.pdf; https://www.epa.gov/system/files/documents/2023-12/epa_scghg_2023_report_final.pdf (last accessed July 3, 2024)

[9] Estimating the Benefit per Ton of Reducing Directly-Emitted PM2.5, PM2.5 Precursors and Ozone Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-pm25-precursors-21-sectors*

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.[10] DOE is currently only monetizing health benefits from changes in ambient fine particulate matter ("$PM_{2.5}$") concentrations from two precursors (SO_2 and NO_X), and from changes in ambient ozone from one precursor (NO_X), but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ 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.

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$
3% discount rate	
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)

[10] 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.

	Billion 2023$
7% discount rate	
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_2), methane (SC-CH_4), and nitrous oxide (SC-N_2O). 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_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 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.

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.[11]

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.[12]

[11] 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.

[12] 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 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_X and SO_2 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 NOx and SO_2 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).

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
3% discount rate			
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)
7% discount rate			
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_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 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.

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 NOx and SO2 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,[13] 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.[14] 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

[13] The information on climate benefits is provided in compliance with Executive Order 12866.
[14] 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).

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 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,[15] added by Pub. L. 95-619, Title IV, section 441(a), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of

[15] As noted previously, for editorial reasons, upon codification in the U.S. Code, Part C was redesignated Part A-1.

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").[16] 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))

[16] "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))

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))

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).

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
		38.0 (M)	≥ 32.0	HZO.RC.M	0.35 x TDA + 2.88

	Horizontal Open (HZO)	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

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").[17] *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 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

[17] The June 2022 Preliminary TSD is available in the docket for this rulemaking at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0013*.

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").[18] *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.

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 *et al.*	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

[18] The October 2023 NOPR TSD is available in the docket for this rulemaking at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0051*.

Food Marketing Institute, National Association of Convenience Stores	FMI and NACS	78	Trade Associations
Hillphoenix**	Hillphoenix	77	Manufacturer
Hoshizaki America	Hoshizaki	76	Manufacturer
Hussmann Corporation	Hussmann	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

To the extent that interested parties have provided written comments that are substantively consistent with any oral comments provided during the 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.3Table 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 *et al.*	106	Efficiency Organizations

Continental Refrigerator	Continental	107	Manufacturer
Hussmann	Hussmann	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 *et al.*	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 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)	USCC et al.	115	Trade Associations
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.[19]

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,

[19] 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*). The references are arranged as follows: (commenter name, comment docket ID number, page of that document).

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, 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 county 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,[20] 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.[21] 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.

[20] See Storemasters, No. 68 at pp. 1–2.

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

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))

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 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.[22] 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

[22] See www.energy.gov/eere/buildings/about-appliance-and-equipment-standards-program

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 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 refrigerant 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,[23] 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

[23] Available at: *www.energystar.gov/products/spec/commercial_refrigerators_and_freezers_specification_version_5_0_pd* (last accessed October 3, 2024).

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. 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.[24]

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

[24] See www.energy.gov/eere/buildings/articles/appliance-and-equipment-standards-fact-sheet.

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) 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)

Hussmann recommended that, in future rulemakings, DOE engage manufacturers, component suppliers, retailers, and other stakeholders early in the process, because Hussmann alleged their equipment has already implemented available technologies, which yielded slight returns in energy savings with excessive cost. (Hussmann, 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 Hussmann 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[25], and the second on Monday, September 16, 2024[26], 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.*

[25] *See www.regulations.gov/document/EERE-2017-BT-STD-0007-0050*
[26] See *www.energy.gov/gc/ex-parte-communications*.

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 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.[27] 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

[27] 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*. September 25, 2024 amendment available at ecf.nysd.uscourts.gov/doc1/127136202802.

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 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_2. (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_2 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*.).[28] NEEA and NWPCC explained that DOE's

[28] 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.

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,[29] 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

[29] *See* www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/72_2022_b_20240830.pdf.

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 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.[30] 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).[31] 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

[30] 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.
[31] DOE also presents a sensitivity analysis that considers impacts for products shipped in a 9-year period.

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.[32] 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.[33] 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

[32] The FFC metric is discussed in DOE's statement of policy and notice of policy amendment. 76 FR 51282 (Aug. 18, 2011), as amended at 77 FR 49701 (Aug. 17, 2012).
[33]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).

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.

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 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*. 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 (≥ 32 °F), freezer (< 32 °F), or ice-cream freezer (≤ -5 °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 °F (± 2 °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 °F (± 2 °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°.

Horizontal open means equipment without doors and an air-curtain angle greater than or equal to 80° 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 °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 °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 °F.

Pull-down temperature application means a commercial refrigerator with doors that, when fully loaded with 12-ounce beverage cans at 90 °F, can cool those beverages to an average stable temperature of 38 °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.

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
	Service Over Counter (SOC)	≥ 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
Self-Contained (SC)	Vertical Open (VOP)	≥ 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
	Semivertical Open (SVO)	≥ 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 Open (HZO)	≥ 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
		≥ 32	HCT.SC.M	0.06 x V + 0.37

	Horizontal Closed Transparent (HCT)	< 32	HCT.SC.L	0.08 x V + 1.23
		≤ -5	HCT.SC.I	0.56 x TDA + 0.43
	Horizontal Closed Solid (HCS)	≥ 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
	Service Over Counter (SOC)	≥ 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
	Pull-Down (PD)	≥ 32	PD.SC.M	0.11 x V + 0.81

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

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.[34]

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.[35] 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[36] ("LAPT") designation for commercial refrigerators, DOE proposed that high-temperature

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[34] 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.

[35] See 10 CFR 431.66(f).

[36] 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.

refrigerators be categorized under the self-contained and remote condensing unit configurations and under the VCT, 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 ≥ x ≥ 32	VOP.SC.M
		LF (0 °F)	x < 32	VOP.SC.L
		IF (-15 °F)	x ≤ -13	VOP.SC.I
	Semivertical Open (SVO)	HR (55 °F)	x > 40	SVO.SC.H*
		MR (38 °F)	40 ≥ x ≥32	SVO.SC.M
		LF (0 °F)	x < 32	SVO.SC.L
		IF (-15 °F)	x ≤ -13	SVO.SC.I
	Horizontal Open (HZO)	HR (55 °F)	x > 40	HZO.SC.H*
		MR (38 °F)	40 ≥ x ≥ 32	HZO.SC.M
		LF (0 °F)	x < 32	HZO.SC.L
		IF (-15 °F)	x ≤ -13	HZO.SC.I
	Vertical Closed Transparent (VCT)	HR (55 °F)	x > 40	VCT.SC.H*
		MR (38 °F)	40 ≥ x ≥ 32	VCT.SC.M
		LF (0 °F)	x < 32	VCT.SC.L
		IF (-15 °F)	x ≤ -13	VCT.SC.I
	Vertical Closed Solid (VCS)	HR (55 °F)	x > 40	VCS.SC.H*
		MR (38 °F)	40 ≥ x ≥ 32	VCS.SC.M
		LF (0 °F)	x < 32	VCS.SC.L
		IF (-15 °F)	x ≤ -13	VCS.SC.I
	Horizontal Closed Transparent (HCT)	CR (38 °F)	x ≥ 32	HCT.SC.M
		LF (0 °F)	x < 32	HCT.SC.L
		IF (-15 °F)	x ≤ -13	HCT.SC.I
	Horizontal Closed Solid (HCS)	CR (38 °F)	x ≥ 32	HCS.SC.M
		LF (0 °F)	x < 32	HCS.SC.L
		IF (-15 °F)	x ≤ -13	HCS.SC.I
	Service Over Counter (SOC)	HR (55 °F)	x > 40	SOC.SC.H*
		MR (38 °F)	40 ≥ x ≥ 32	SOC.SC.M
		LF (0 °F)	x < 32	SOC.SC.L
		IF (-15 °F)	x ≤ -13	SOC.SC.I
	Pull-Down (PD)	CR (38 °F)	x ≥ 32	PD.SC.M
	Chef Base or Griddle Stand (CB)	CR (38 °F)	x ≥ 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 ≥ x ≥ 32	VOP.RC.M
		LF (0 °F)	x < 32	VOP.RC.L
		IF (-15 °F)	x ≤ -13	VOP.RC.I
		HR (55 °F)	x > 40	SVO.RC.H*

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

<u>New and Amended Definitions Adopted in This Final Rule</u>

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^3) 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^3 unit may not apply to a 24-ft^3 unit. (*Id*. at p. 6) NAMA stated that doors, insulation, fan motors, compressors, and evaporator coils would be different for 30-ft^3 models compared to 60-ft^3 models. (*Id.*) NAMA commented that, for DOE's analysis, units under 30 ft^3 should be considered as different from those over 30 ft^3 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^3. (*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[37] 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^3. 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^3 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 and energy efficiency for a 60-ft^3 unit compared to a 24-ft^3 unit, DOE notes that the representative analyzed volume for the VCT.SC.M class in the October 2023 NOPR was 49 ft^3, not 60 ft^3, 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^3 and two doors. A majority of these manufacturers also have models with certified volumes close to the

[37] See *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A**.

VCT.SC.M representative volume analyzed in this final rule (*e.g.*, 43.75 ft^3, 41.11 ft^3, and 40.7 ft^3).

DOE is maintaining the 49 ft^3 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^3, DOE conducted an analysis using its engineering spreadsheet to estimate the energy use of a CRE model with 24 ft^3 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^3 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^3.

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.[38] 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 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.

[38] 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).*

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^3 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^3 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).[39] 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,[40] and the PD.SC.M energy use standard is less stringent than the comparable VCT.SC.M- class energy use standard above 5 ft^3. 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.

[39] See 119 STAT. 639 at *www.govinfo.gov/content/pkg/PLAW-109publ58/pdf/PLAW-109publ58.pdf*.
[40] See *www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial__Single_Compartment.html#q=Product_Group_s%3A%22Refrigeration%20Equipment%20-%20Commercial%2C%20Single%20Compartment%22*.

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[41] supplemented by information from CEC's MAEDbS,[42] 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

[41] U.S. Department of Energy's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (last accessed Jan. 31, 2024).
[42] California Energy Commission's Modernized Appliance Efficiency Database is available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed Jan. 31, 2024).

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.

Table IV.3 Technology Options for CRE

Insulation	**Evaporator**
Improved resistivity of insulation (insulation type)	Increased surface area
Increased insulation thickness	Improved evaporator coil design
Vacuum-insulated panels	Low-pressure differential evaporator
Lighting	**Condenser****
Higher-efficiency lighting	Increased surface area**
Occupancy sensors	Tube-and-fin enhancements**
Improved transparent doors*	Microchannel condenser**
Low-emissivity coatings*	**Fans and fan motors**
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**
Compressors**	**Other technologies**
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)

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")[43], DOE revised its calculation of energy use for all compressors to be 5 percent higher than calculated using compressor performance

[43] For the AHRI white paper see www.ahrinet.org/system/files/2023-06/compressors-white-paper.pdf.

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 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 ± 2 °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 insultation 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,[44] 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.

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

[44] *See* November 2023 Public Meeting Transcript, No. 64 at pp. 59–60.

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,[45] 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

[45] *See qmpower.com/products/.*

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 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.[46]

In response to the October 2023 NOPR, Hillphoenix, ITW, NAMA, NAFEM, and Ravnitzky commented with concern regarding the food safety implications of incorporating

[46] See section 5.5.6 of the October 2023 NOPR TSD, located at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0051*.

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 + OCDT + 50% x (24 – CRT – OCDT), where RT = Compressor Runtime OCDT = 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 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 ± 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.[47] (*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 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

[47] *See* section 5.5.2 of the Residential Refrigerator NOPR TSD at *www.regulations.gov/document/EERE-2017-BT-STD-0003-0045*.

current uncertainty as to the practicability to manufacturer, 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

Insulation	**Condenser****
Improved resistivity of insulation (insulation type)	Increased surface area**
Lighting	Tube-and-fin enhancements**
Higher-efficiency lighting	**Fans and fan motors**
Occupancy Sensors	Evaporator fan motors
Improved transparent doors*	Evaporator fan blades
Low-emissivity coatings*	Condenser fan motors**
Inert gas fill*	Condenser fan blades**
Vacuum-insulated glass*	Condenser fan controls**
Additional panes*	**Compressor****
Anti-sweat heater controls*	Improved compressor efficiency**
Anti-fog films*	Alternative refrigerants**
Frame design*	Variable-speed compressors**
Evaporator	**Other technologies**
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 great than (CB.SC.M > 84”) and freezer models having widths great 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 DOEs 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),[48] 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 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).[49] 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

[48] See *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102*.
[49] See *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102*.

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 were finalized in the October 2023 EPA Final Rule.

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

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[50] 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 ("IAMPO")." In May 2024, the ICC published the 2024 I-Codes,[51] including the 2024 International Mechanical Code ("2024 IMC")[52]. 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

[50] See *www.achrnews.com/articles/147113-finalizing-the-a2l-provisions-in-2024-mechanical-codes*.
[51] See *http://codes.iccsafe.org/codes/i-codes/2024-icodes*.
[52] See *http://codes.iccsafe.org/content/IMC2024V1.0/chapter-11-refrigeration*.

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. 66 at p. 2) Additionally, DOE notes that over 93 percent of ENERGY STAR equipment have already transitioned to low GWP, hydrocarbon refrigerants. [53] 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

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

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^3 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.[54] *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^2 in the 2013 NOPR to 4.78 ft^2 in the March 2014 Final Rule.[55]

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

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[54] 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.

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

presented analytical results of this approach for each of these seven equipment classes. *Id*. at 89 FR 68790-68791.

Table IV.6 Equipment Classes with Two Representative Capacities

Condensing Unit Configuration	Equipment Family	Operating Temperature (°F)	Equipment Class Designation	Volume ("V") [ft^3] or TDA [ft^2] Range	Representative Capacity [ft^3] or [ft^2]
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.

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)[56], 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

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[56] The values included in the text have been calculated as prescribed by the EPA in 40 CFR 64.64

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 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^3 utilizing R-290 refrigerant and observed units utilizing R-290 as small as 2.34 ft^3.[57] 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)

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,[58] 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

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[57] See www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial__Single_Compartment.html#fq=Chilled_or_Frozen_Volume_in_cubic_feet__ft3____if_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".

[58] See www.energystar.gov/productfinder/product/certified-commercial-refrigerators-and-freezers/results.

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 US-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)

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.

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

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 R290 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^3 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^3, 12.98 ft^3, and 23.90 ft^3.

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,[59] 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,

[59] See *www.youtube.com/watch?v=aETuPis5cAM.*

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^2- °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.[60] (Hussmann, No. 80 at p. 5) Hussmann agreed with DOE's determination in the October 2023 NOPR TSD to use an adjusted R-

[60] *The October 2023 NOPR engineering analysis spreadsheet is available at www.regulations.gov/document/EERE-2017-BT-STD-0007-0055.*

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)

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 ≤ 0.125	R ≥ 8	14.29	1
0.125 < K ≤ 0.130	8 > R ≥ 7.7	0	0
0.130 < K ≤ 0.135	7.7 > R ≥ 7.4	14.29	1
0.135 < K ≤ 0.140	7.4 > R ≥ 7.1	14.29	1
0.140 < K ≤ 0.145	7.1 > R ≥ 6.9	14.29	1
0.145 < K ≤ 0.150	6.9 > R ≥ 6.7	14.29	1
0.150 < K ≤ 0.155	6.7 > R ≥ 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.

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.[61] 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

[61] See table 5.5.4 of the Preliminary Analysis TSD, available at www.regulations.gov/document/EERE-2017-BT-STD-0007-0016.

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.

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

Equipment Class	2014 Final Rule	Preliminary Analysis	NOPR	Final Rule (same as August 2024 NODA)
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,	1.5	1.5	2.5	1.5

VCS.SC.M, HCT.SC.M, HCS.SC.M				
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^3 [in]	% of Responses	# of Responses
X ≤ 1.5	28.57	2
1.5 < X ≤ 1.75	28.57	2
1.75 < K ≤ 2	14.29	1
2 < K ≤ 2.25	28.57	2
2.25 < K ≤ 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,[62] 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

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[62] *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*.

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.*) ARHI 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 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*.) [63]

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

[63] EPCA states the following at 42 USC 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 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))

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 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.[64] 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.[65]

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.

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[64] See section 5.5.8.2 and appendix 5A.2 of the October 2023 NOPR TSD.
[65] 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*.

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 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 conductions 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.

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

The updates to the final rule engineering assumptions outlined above are consistent with the approach in the March 2014 Final Rule where DOE 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.[66]

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*.,

[66] 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* and *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102*.

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 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.[67] 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

[67] See section 5.7.2.8, Variable-Speed Condenser Fan Control, at *www.regulations.gov/document/EERE-2017-BT-STD-0009-0093* at pp. 5–60.

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 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,[68] 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 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)

[68] *See www.regulations.gov/document/EERE-2017-BT-STD-0007-0090.*

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^3), 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.[69] 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.[70] In the March 2014 Final Rule, precedent was established for an update to the analysis approach for compressors, where DOE updated

[69] See the calculations tab of the engineering spreadsheet at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0055.*

[70] See section 5.5.3.1 of the October 2023 NOPR TSD at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0051*.

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[71]. 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

[71] *See www.regulations.gov/document/EERE-2017-BT-STD-0007-0091*

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 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 mis-application 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 de-activation (*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 de-activation 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.[72] (*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

[72] *See www.buildinggreen.com/product-review/saving-energy-supermarkets-vacuum-insulated-glass.*

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 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.[73] 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

[73] See *valprorefrigeration.com/glass-door-merchandisers/glass-door-freezer-merchandisers/two-swing-glass-door-merchandiser-freezer-vp2f-48hc/*.

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;[74] 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

[74] See chapter 5, section 5.8 of the June 2022 Preliminary TSD at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0013.*

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 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 68794. To select a single multiplier representative of the range of features analyzed, DOE used an equipment class shipment-weighted average of the eligible equipment class unweighted average multiplier values based on the features applicable for each class. *Id.* The result of this single multiplier analysis yielded a multiplier of 1.07. *Id.* DOE applied this multiplier to the representative energy use at each efficiency level for each eligible class and presented the resulting energy use equations in the August 2024 NODA. *Id.*

In response to the August 2024 NODA, ITW commented that it supports the concept of a "simplified multiplier" for eligible equipment classes and feature groupings, including pass-through, sliding door, sliding-door pass-through, roll-in, roll-through and drawers. (ITW, No. 111, pp. 1-2) ITW commented that they do not support DOE's proposed 1.07 multiplier, because their analysis indicates a multiplier value significantly higher associated with some features and recommends a compromise for the "simplified multiplier" of 1.11 to 1.15 rather than 1.07. (*Id.* at p. 2) ITW's analysis yielded a multiplier of 1.07 for pass-through classes and sliding classes, 1.11 for pass-through and sliding classes, 1.06 for roll-in classes, 1.14 for roll-through classes, and 1.27 for drawer classes. *Id.*

ITW commented that they appreciate DOE's understanding that ancillary losses are significantly higher in equipment with drawers versus equipment with doors to merit their inclusion in the grouping of CRE with features that affect energy use. (*Id*.)

Hillphoenix commented that the forced-air evaporator configuration proposed in the October 2023 NOPR only applied to equipment class HCS.SC.L. (Hillphoenix, No. 110 at p. 6) Hillphoenix commented also that in the October 2023 NOPR engineering analysis spreadsheet for HCT.SC.M, L, and I product classes, there was no energy included for the evaporator fans motors or anti-sweat heat, which assumes that all products in this class are considered by DOE to utilize cold wall evaporators. (*Id.*) Hillphoenix stated that this assumption does not accurately reflect the larger units in this class which utilize evaporators and fans. (*Id.*) Hillphoenix commented that the forced air evaporator configuration needs to be included in the HCT.SC class, and that this class must include evaporator fans and anti-sweat energy. (*Id*). Hillphoenix stated its belief that HCT.RC, HCT.SC, HZO.RC, HZO.SC with glass sides are not suitable for cold wall evaporators because the refrigerant piping cannot be installed in the glass which surrounds the product. (*Id.*)

Delfield supported the need for new classifications on specialty cabinets, however, they found that the suggested allowances for most of these categories are not reasonable. (Delfield, No. 99 at p. 2) Delfield commented that any additional allowances for these categories should consider the refrigerated volume of the cabinet rather than a fixed number as proposed in some of the categories. (*Id.*) Delfield disagreed that a single use multiplier can be used effectively on pass-through doors , sliding doors and roll-ins since these categories have different challenges with widely different energy consumptions. (*Id.*) Delfield recommend either leaving these categories at DOE 2017 levels or moving forward with a 20 percent allowance for pass-through doors , sliding doors and roll-ins versus VCS.SC.M, VCS.SC.L, VCT.SC.M and VCT.SC.L classifications and an additional 20 percent for roll-throughs and pass-throughs with sliding doors . (*Id.*)

Delfield also suggested that DOE add an additional classification for freezers with drawers stating they require additional heater wires and gaskets which contribute to increased energy consumption. (*Id*. at p. 3) Delfield ultimately recommended that DOE stays at 2017 DOE levels for freezers with drawers. (*Id.*)

In response to ITW's and Delfield's comments requesting an alternative single multiplier, DOE notes that neither ITW, Delfield, nor any other commenter, provided data to support a multiplier different from the multiplier presented in the August 2024 NODA. DOE conducted a review of the data that supported the August 2024 NODA multiplier and has determined that it continues to be representative of the eligible features included in the August 2024 NODA and this final rule.

In response to Hillphoenix's comment, DOE notes that it is not aware of any models certified to DOE's CCD in the HCT.SC class which use forced-air evaporators, including the

HCT.SC models Hillphoenix has certified to DOE.[75] Further, the HCT.SC and HCT.RC models that Hillphoenix has certified to the CCD are all medium-temperature refrigerators and low-temperature freezers. In this final rule, DOE is not amending the standards for HCT.SC.M, HCT.SC.L, HCT.RC.M, and HCT.RC.L. In regards to the HZO.RC and HZO.SC classes, in the October 2023 NOPR analysis, the August 2024 NODA analysis, and this final rule, DOE has assumed that the HZO.RC and HZO.SC classes use forced air evaporators, which is consistent with Hillphoenix's feedback. Therefore, DOE has determined that its analysis is representative of the current market.

In response to Delfield's comment, the multiplier equations presented in the August 2024 NODA do vary by capacity (*i.e.,* volume or TDA). Additionally, based on the data supporting the development of the multipliers in this final rule, DOE has determined that a single energy use multiplier is representative of the entire capacity range of the equipment class. In support of this final rule, DOE is not aware and has not received any data to support different multipliers for different capacity ranges within an equipment class.

In response to these comments and consistent with the August 2024 NODA analysis, in this final rule, DOE is adopting a single 1.07 multiplier for all equipment classes proposed in the October 2023 NOPR with qualifying features, including pass-through doors, sliding door, sliding-door pass-through doors, roll-in door, roll-through doors, forced-air evaporator,

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[75] See *www.regulations.doe.gov/certification-data/CCMS-4-Refrigeration_Equipment_-_Commercial_Single_Compartment.html#fq=%7B!tag%3DBrand_Name_s_s%7DBrand_Name_s_s%3AHillphoenix&fq=%7B!tag%3DEquipment_Family_Description_s%7DEquipment_Family_Description_s%3A%22Horizontal%20Closed%20Transparent%20%5C(HCT%5C)%22&fq=%7B!tag%3DCondensing_Unit_Configuration_Description_s%7DCondensing_Unit_Configuration_Description_s%3A%22Self%5C-Contained%20%5C(SC%5C)%22&q=Product_Group_s%3A%22Refrigeration%20Equipment%20-%20Commercial%2C%20Single%20Compartment%22*. Accessed on 10/30/24.

and drawer units. These performance-related features may have interdependencies that affect energy performance, and, therefore, DOE has determined that a single, consolidated 1.07 multiplier for all equipment classes is representative of the energy use characteristics of these features. DOE is adopting separate equipment classes for certain equipment categories with one or more qualifying performance-related features. Table IV.15 indicates for which equipment classes and features this distinction (and the allowed additional energy use) is applicable. DOE is establishing these equipment classes with features with an energy conservation standard (in kWh/day) that equals 1.07 multiplied by the equation for the related equipment class that does not contain these features. With respect to comments from ITW and Delfield regarding the inclusion of units with drawers in the multiplier, DOE notes that the August 2024 NODA 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^3)
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[76] 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 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

[76] AHRI specifically referenced *American Public Gas Association v U.S. Department of Energy*, 72 F. 4th 124, July 7, 2023.

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^3) or TDA (ft^2)	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.[77]

In response to the August 2024 NODA, The CA IOUs commented that, changing engineering assumptions from 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

[77] *See* Section 1.3 of the NODA support document at https://www.regulations.gov/document/EERE-2017-BT-STD-0007-0090

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.[78]

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

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[78] See tables 5.A.2.2 of the NOPR and March 2014 Final Rule TSD, available at *.regulations.gov/document/EERE-2010-BT-STD-0003-0051* and *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102.*

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.[79]

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 levelized 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

[79] *See* section 5.8 at *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102*.

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 EPACT 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^3 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^3 is also representative for volumes less than 49 ft^3.

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,[80] 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.*)

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

[80] *See www.energystar.gov/products/commercial_refrigerators_freezers/partners?_gl=1*mzqc33*_ga*MTkwMzQyNTg3LjE3MDU0MjQ1OTk.*_ga_S0KJTVVLQ6**MTcxNDA4Mzg1MC4xNy4xLjE3MTQwODM4NTMuMC4wLjA.

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 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^3, 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^3 in capacity would use design options significantly different than larger equipment; therefore, DOE has not considered different costs for machines under 30 ft^3 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"),[81] 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.

[81] Occupational wage statistics data are available at *www.bls.gov/oes/*.

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 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 NAMAs 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 complains 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.[82]

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

[82] See the NOPR and March 2014 Final Rule engineering spreadsheets available at *www.regulations.gov/document/EERE-2010-BT-STD-0003-0098* and *www.regulations.gov/document/EERE-2010-BT-STD-0003-0059,* respectively.

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.[83] 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[84] 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[85] referenced a manufacturer markup of 1.42. (*Id.*) In response to the August 2024 NODA, Hillphoenix commented that DOE's suggested

[83] 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 and the March 2014 Final Rule TSD is available at *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102*.
[84] SEC's Electronic Data Gathering, Analysis, and Retrieval system is available at *www.sec.gov/edgar/searchedgar/companysearch* (last accessed April 15, 2024).
[85] Available at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0055*.

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.[86]

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, along with

[86] The Final Rule Engineering Analysis Spreadsheet Model is available at *www.regulations.gov/docket/EERE-2017-BT-STD-0007/document*.

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),[87] 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[88] and other public sources (*e.g.*, trademark information from JUSTIA).[89] 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.

[87] ImportYeti, LLC. "ImportYeti." Available at: *www.importyeti.com/* (Last accessed April 25, 2024).
[88] The U.S. Patent and Trademark Office's Trademark Search is available at *tmsearch.uspto.gov/search/search-information* (last accessed Sept. 9, 2024).
[89] JUSTIA, "Trademarks." Available at *trademarks.justia.com/* (last accessed Sept. 9, 2024).

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.[90]

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

[90] 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 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.

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 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"),[91] 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

[91] 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/* (last accessed Sept. 9, 2024).

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 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. 89 FR 68788, 68794. The remaining 25 percent would incur the increased equipment cost but not the associated energy savings.[92] *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,

[92] 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.

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 de-activation 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 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 *AEO2023*[93] 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).**
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^2, while large buildings are defined as those greater than 5,000 ft^2
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.

93 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/* (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.[94] 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 programing 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

[94] Semiconductors and related device manufacturing PPI series ID: PCU334413334413; available at *www.bls.gov/ppi/* (last accessed Sept. 9, 2024).

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 kilowatthour 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).[95]

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.[96] 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^2) and small-size (less than 5,000 ft^2) 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.

[95] 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* (last accessed Sept. 9, 2024)
[96] EIA. *Annual Energy Outlook 2023*. Available at *www.eia.gov/outlooks/aeo/* (last accessed Sept. 9, 2024).

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 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"),[97] 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

[97] See Advanced Energy Retrofit Guides for Grocery Stores, available at *www.nrel.gov/docs/fy13osti/54243.pdf* (last accessed Sept. 9, 2024).

night curtain replacement labor duration at the same labor rates (according to RSMeans 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.[98] 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

[98] Weibull distributions are commonly used to model appliance and equipment lifetimes.

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 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.[99] 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

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[99] Damodaran, A. Data: Cost of Capital by Industry Sector, United States. 2023. Available at *pages.stern.nyu.edu/~adamodar/* (last accessed Sept. 9, 2024).

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.[100]

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

[100] U.S. Department of Energy. Compliance Certification Database ("CCD") for Refrigeration Equipment – Commercial, Single Compartment. Available at *www.regulations.doe.gov/certification-data/* (last accessed February. 9, 2024).

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..[101] *Id*. For the remainder of the equipment classes for which DOE was not able to collect representative shipments data from manufacturers due

[101] 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.

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.

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.[102] The study found that multiple 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

[102] DeCanio, S. J. (1998). "The Efficiency Paradox: Bureaucratic and Organizational Barriers to Profitable Energy-Saving Investments," *Energy Policy*, 26(5), 441–454.

adoption of energy-efficient technologies in a variety of commercial sectors around the world, including office buildings,[103] supermarkets,[104] and the electric motor market.[105]

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[106]. 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.

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[103] 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.
[104] 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.
[105] 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* (last accessed Sept. 9, 2024).
[106] 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.

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.[107] 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.[108] 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.[109] 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.[110] These characteristics describe almost all purchasing situations of appliances

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[107] 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: w*ww.sciencedirect.com/science/article/abs/pii/S0301421510009171*) (Last accessed January 5, 2024).
[108] Thaler, R.H., Sunstein, C.R., and Balz, J.P. (2014). "Choice Architecture" in *The Behavioral Foundations of Public Policy*, Eldar Shafir (ed).
[109] Thaler, R.H., and Bernartzi, S. (2004). "Save More Tomorrow: Using Behavioral Economics in 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).
[110] Thaler, R.H., and Sunstein, C.R. (2008). Nudge: Improving Decisions on Health, Wealth, and Happiness. New Haven, CT: Yale University Press.

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")[111] (*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 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

[111] Available at *www.gao.gov/assets/gao-23-105846.pdf*(last accessed Sept. 9, 2024).

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.[112] 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.

[112] 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.

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 saturations 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.[113] DOE's shipment results are

[113] 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* (last accessed July 29, 2024).

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 refurbishments. AHRI commented that energy efficiency gains are lost when consumers refurbish CRE and argued that refurbished CRE could cost up to 45 percent less than new CRE, causing the refurbished market to grow. (AHRI, No. 81 at pp. 8, 11–12)

According to AHRI, their surveyed suppliers of refurbished equipment reported double-digit growth in the past few years. (*Id.* at p. 12) Hussmann emphasized the growth of the refurbishment market due to increased costs and payback periods and commented that the compound annual growth rate ("CAGR") of the refurbishment industry in FY20, FY21, FY22 was 23 percent, 25 percent, and 11 percent, respectively. (Hussmann, No. 80 at p. 9) Further, Hussmann estimated a 10 percent annual growth in this market since 2015. (*Id*. at pp. 9–10) Hillphoenix commented that the cost of refurbished equipment is usually 50 percent less than the cost of new CRE, and that two large U.S. retailers are currently considering establishing their own in-house refurbishment program. (Hillphoenix, No. 77 at p. 2) Hillphoenix emphasized the growth of the refurbished market due to supply chain shortage and component cost increases, and stated there are at least 20 companies that refurbish CRE and suggested DOE reach out to those companies. (*Id*.) NAFEM commented that increased equipment prices are leading to refurbishment in all business sizes. (NAFEM, No. 83 at pp. 18, 23) NAMA also requested that DOE evaluate the energy use of refurbished machines and estimate the impact that equipment price increases associated with new standards may have on delaying purchase of new CRE or incentivizing purchase of refurbished CRE. (NAMA, No. 85 at pp. 16–17) NAMA added that any changes in the design options will cause significant increases in the cost of the machines, which will cause the purchaser to consider other alternatives including delaying the purchase of new equipment, purchasing refurbished machines, and importing machines from overseas, all of which will delay energy savings from being realized. (NAMA, No. 85 at p. 19) Furthermore, Storemasters commented that increased equipment prices would lead to fewer independent retailers opening new branches or remodeling existing ones. (Storemasters, No. 68 at p. 1)

In response to the August 2024 NODA, several stakeholders reiterated their concern about the growth of the refurbishment market, and its impact on energy savings as an unregulated industry. Hillphoenix commented that the lower cost of refurbished CRE drives the growth of the refurbishment market and suggested that DOE reach out to the more than 20 retailers dealing in refurbished equipment for data on the size and growth of the refurbishment industry. (Hillphoenix, No. 110 at p. 2) NAMA commented that the design options analyzed would significantly increase equipment costs, which could result in consumers purchasing refurbished CRE or delaying the purchase of new CRE. (NAMA, No. 112 at p. 6) AHRI restated their concern that the new standards will increase CRE costs, causing customers to buy less energy efficient, refurbished CRE. (AHRI, No. 104 at p. 8)

To account for the effect of a potential increase in refurbished CRE as a result of increased prices from CRE standards, in the October 2023 NOPR, DOE had assumed a price elasticity effect for a small fraction of CRE shipments, which was limited to small-sized buildings. 88 FR 70196, 70242. In response to the stakeholder comments on refurbished CRE, in the August 2024 NODA, DOE modified its price elasticity approach based on the premise that if the refurbishment market offers a favorable economic opportunity, it could be utilized by all businesses. Accordingly, for the August 2024 NODA DOE applied price elasticity to all self-contained units, regardless of the building size where those units are installed. DOE notes that the price elasticity effect and a resulting reduction in CRE shipments is dependent on the price difference between the price consumers pay in the no-new-standards case and the standards case. DOE applied an elasticity constant of -0.5 to shipments for self-contained CRE and scaled this constant down to -0.15 over a period of 20 years (then constant thereafter) from the current year of calculations. DOE also acknowledges that, while a CRE refurbishment market may well exist and its magnitude may have recently increased due to supply chain and equipment price increases, this phenomenon applies to the CRE market overall and is not a result of energy efficiency standards on CRE. With regard to self-contained units, DOE estimates that their market share is approximately 86 percent of the new (*i.e.*, not refurbished) CRE market within the scope of this final rule. DOE notes that decision makers consider many other factors aside CRE purchase price when evaluating business openings or expansions, including the operating cost of CRE over the lifetime of the equipment, as well as other business factors. Nonetheless, because more efficient CRE would actually lead to *increased* shipments in the standards cases if DOE were to account for efficiency elasticity, DOE followed a conservative approach and did not account for efficiency elasticity in its shipments analysis. In response to the comment from NAMA regarding importing machines from overseas, DOE notes that 10 CFR 429.5(a) states that any person importing any covered product or covered equipment into the United States shall comply with the provisions of this part, and parts 430 and 431, and is subject to the remedies of this part.

As discussed in section IV.F.7, following the August 2024 NODA, AHRI, Hillphoenix and Hussmann commented 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, potentially rendering such CRE subject to price elasticity, in addition to self-contained CRE. To account for the potential impact in the NIA and MIA of all CRE being subject to refurbishments, DOE applied price elasticity to all CRE shipments as part of a sensitivity analysis. The results of this analysis show that at the selected TSL (TSL 3), there is a 0.39 percent decrease in the cumulative shipments compared to the no-new standards case, in the first 5 years after the rulemaking compliance year (2029). See appendix 10C of the final rule TSD for more details. The MIA results of the sensitivity analysis indicate a minimal impact in the change in INPV at TSL 3 as compared to the change in INPV at TSL 3 for the reference scenario. See chapter 12 of the final rule TSD for the MIA results of the price elasticity sensitivity analysis. Consistent with the August 2024 NODA, in this final rule, DOE continues to apply price elasticity to all-self-contained CRE as its reference scenario. At the selected TSL for the reference scenario, there is a 0.37 percent decrease in the cumulative shipments compared to the no-new standards case, in the first 5 years after the rulemaking compliance year (2029).

In response to the October 2023 NOPR and the August 2024 NODA, Hillphoenix commented that the proposed standards for many of the closed equipment classes (*e.g.*, HCT, VCT, and VCS) are concerning, as the industry continues to transition to closed cases for additional energy savings. (Hillphoenix, No. 77 at p. 1; Hillphoenix, No. 110 at p. 1) Hillphoenix commented that the cost increase of closed cases required to implement the design changes necessary will slow the transition from open cases to more energy-efficient closed-door models. (*Id.*) Hillphoenix stated that any CRE with lids or doors saves approximately 60-percent energy over their open-display counterparts. (*Id.*) Hillphoenix stated that many retailers have converted their VOP/HZO open cases to VCT/HCT classes by retrofitting doors in existing installations to capture the aforementioned energy savings, but requirements for further energy reduction will lead to many closed products being discontinued from the market, which is counter to the goal of reducing energy consumption. (*Id.*)

Regarding the transition from open to closed cases and how standards may affect this transition, DOE reviewed the first cost increase of open cases (VOP and HZO equipment families) relative to corresponding door cases (VCT and HCT equipment families, respectively) between the no-new-standards case and the standards-cases evaluated by DOE and determined that, overall, the increase in first cost for door case equipment classes is smaller than that for open case equipment classes at the considered standard levels. Therefore, DOE concludes that the transition from open to closed cases will not be affected by standards.

In response to the October 2023 NOPR, NAMA commented that DOE's shipments estimates are incorrect and may be off by as much as 50 percent and added that there is no specific information on shipments by category in the October 2023 NOPR TSD. (NAMA, No. 85 at p. 3) Furthermore, NAMA commented that while most of the projections on cost, capital, and utility concerns in the October 2023 NOPR TSD refer to CRE connected to a refrigerant supply system, the impact on self-contained units is much greater and stated that this is not acknowledged in the October 2023 NOPR TSD or the October 2023 NOPR. (*Id.* at p. 10) NAMA recommended that DOE review data from ENERGY STAR regarding shipments with which to modify the percentages according to sales-weighted numbers, which would likely result in a significant effect on the equipment within NAMA's scope. (*Id*.) NAMA also requested that DOE use shipment data of new rather than a collection of new and refurbished units. (*Id*. at p. 20)

In response to the August 2024 NODA, NAMA reiterated the claim that DOE's shipments estimates are off by as much as 50 percent, and that refurbished units have not been accounted for in this data. (NAMA, No. 112 at p. 5) NAMA also repeated their request for information on shipments. (*Id.* at p. 6-7)

In response to the comments from NAMA, DOE notes that shipment estimates by equipment class are available in chapter 9 of the October 2023 NOPR TSD, as well as chapter 9 of this final rule TSD. In this final rule, total CRE shipments in 2029 are estimated to be 1.42 million units. DOE clarifies that all data inputs for shipments estimates are associated with new units. Also, as discussed earlier in this section, DOE reviewed historical CRE ENERGY STAR shipments data to estimate CRE shipments and self-contained units specifically. For self-contained units, DOE used estimates based on manufacturer interviews in 2022 to determine that their market share is approximately 86 percent of the CRE market covered by this final rule.

Chapter 9 of the final rule TSD provides additional details regarding the shipments analysis.

H. National Impact Analysis

The NIA assesses the NES and the NPV from a national perspective of total consumer costs and savings that would be expected to result from new or amended standards at specific efficiency levels.[114] ("Consumer" in this context refers to consumers of the equipment being regulated.) DOE calculates the NES and NPV for the potential standard levels considered based on projections of annual equipment shipments, along with the annual energy consumption and total installed cost data from the energy use and LCC analyses. For the present analysis, DOE projected the energy savings, operating cost savings, equipment costs, and NPV of consumer benefits over the lifetime of CRE sold from 2029 through 2058.

DOE evaluates the impacts of new or amended standards by comparing a case without such standards with standards-case projections. The no-new-standards case characterizes energy use and consumer costs for each equipment class in the absence of new or amended energy conservation standards. For this projection, DOE considers historical trends in efficiency and various forces that are likely to affect the mix of efficiencies over time. DOE compares the no-new-standards case with projections characterizing the market for each equipment class if DOE adopted new or amended standards at specific energy efficiency levels (*i.e.*, the TSLs or standards cases) for that class. For the standards cases, DOE considers how a given standard would likely affect the market shares of equipment with efficiencies greater than the standard.

[114] The NIA accounts for impacts in the United States and U.S. territories.

DOE utilized the Python programming language for its NIA to calculate the energy savings and the national consumer costs and savings for each TSL. The final results of this analysis are available in the NIA spreadsheet, accessible at *www.regulations.gov/docket/EERE-2017-BT-STD-0007*. Interested parties can review DOE's analyses by changing various input quantities within the spreadsheet. The NIA spreadsheet model uses typical values (as opposed to probability distributions) as inputs.

Table IV. summarizes the inputs and methods DOE used for the NIA analysis for this final rule. Discussion of these inputs and methods follows Table IV.. See chapter 10 of the final rule TSD for further details.

Table IV.20 Summary of Inputs and Methods for the National Impact Analysis

Inputs	Method
Shipments	Annual shipments from shipments model.
Compliance Date of Standard	2029
Efficiency Trends	N/A (No efficiency trends were applied)
Annual Energy Consumption per Unit	Annual weighted-average values are a function of energy use at each TSL.
Total Installed Cost per Unit	Annual weighted-average values are a function of cost at each TSL. Incorporates projection of future equipment prices based on historical data.
Annual Energy Cost per Unit	Annual weighted-average values as a function of the annual energy consumption per unit and energy prices.
Repair and Maintenance Cost per Unit	Annual, weighted-average values from the LCC model.
Energy Price Trends	Prices from LCC analysis and *AEO2023* projections (to 2050) and extrapolation after 2050.
Energy Site-to-Primary and FFC Conversion	Time-series conversion factors based on *AEO2023*.
Discount Rate	3 percent and 7 percent
Present Year	2024

1. Equipment Efficiency Trends

A key component of the NIA is the trend in energy efficiency projected for the no-new-standards case and each of the standards cases. Section IV.F.9 of this document describes how DOE developed an energy efficiency distribution for the no-new-standards case (which yields a shipment-weighted average efficiency) for each of the considered equipment classes for the year of anticipated compliance with an amended or new standard.

For the standards cases, DOE used a "roll-up" scenario to establish the shipment-weighted efficiency for the year that standards are assumed to become effective (2029). In this scenario, the market shares of equipment in the no-new-standards case that do not meet the standard under consideration would "roll up" to meet the new standard level, and the market share of equipment above the standard would remain unchanged.

In the October 2023 NOPR, due to an absence of data on trends in efficiency, DOE assumed no efficiency trend over the analysis period for both the no-new-standards and standards cases. 88 FR 70196, 70244. For a given equipment class, market shares by efficiency level were held fixed to their estimated distribution in 2029.[115] *Id*.

In response to the October 2023 NOPR, AHRI recommended that DOE review its CCD for efficiency data and trends. (AHRI, No. 81 at p. 12) Hussmann provided data on the efficiency improvement of one of its highest volume cases in the VOP.RC.M equipment class and showed a 46-percent reduction in energy use between 1985 and 2023. (Hussmann,

[115] DOE notes that, as discussed in section IV.C.1.a.i of this document, DOE has accounted for CRE efficiency trends by assuming that all self-contained units will have transitioned to R-290 (propane) by the compliance year (2029).

No. 80 at p. 11–12) Hussmann further stated that other equipment classes, such as VCT.RC.L, have shown similar trends. (*Id.*) DOE appreciates the comments and data provided by AHRI and Hussmann. DOE reviewed CCD data between 2017 and 2024 and did not identify a significant pattern in CRE efficiency trends. Furthermore, DOE notes that the energy efficiency improvement from the March 2014 Final rule and the energy efficiency improvement reported by Hussmann for the VOP.RC.M class between 2012 and 2023 are similar. Therefore, the efficiency improvement provided by Hussmann in recent years may be a result of the March 2014 Final Rule, and not an efficiency improvement trend in the absence of standards. Hence, for this final rule, DOE continued to assume no trend in efficiency in the no-new-standards and the standards cases.

2. National Energy Savings

The NES analysis involves a comparison of national energy consumption of the considered equipment between each potential standards case (*i.e.*, TSL) and the case with no new or amended energy conservation standards. DOE calculated the national energy consumption by multiplying the number of units (*i.e.*, stock) of equipment (by vintage or age) by the unit energy consumption (also by vintage). DOE calculated annual NES based on the difference in national energy consumption for the no-new-standards case and for each higher efficiency standard case. DOE estimated energy consumption and savings based on site energy and converted the electricity consumption and savings to primary energy (*i.e.*, the energy consumed by power plants to generate site electricity) using annual conversion factors derived from *AEO2023*. Cumulative energy savings are the sum of the NES for each year over the timeframe of the analysis.

Use of higher-efficiency equipment is sometimes associated with a direct rebound effect, which refers to an increase in utilization of the equipment due to the increase in efficiency and reduction in operating cost. DOE did not find any data on the rebound effect specific to CRE that would indicate end-users or CRE purchasers would alter the utilization of their equipment as a result of an increase in efficiency. CRE are typically plugged in and operate continuously; therefore, DOE assumed a rebound rate of 0.

In 2011, in response to the recommendations of a committee on "Point-of-Use and Full-Fuel-Cycle Measurement Approaches to Energy Efficiency Standards" appointed by the National Academy of Sciences, DOE announced its intention to use FFC measures of energy use and GHG and other emissions in the NIA and emissions analyses included in future energy conservation standards rulemakings. 76 FR 51281 (August 18, 2011). After evaluating the approaches discussed in the August 18, 2011 notice, DOE published a statement of amended policy in which DOE explained its determination that EIA's National Energy Modeling System ("NEMS") is the most appropriate tool for its FFC analysis and its intention to use NEMS for that purpose. 77 FR 49701 (August 17, 2012). NEMS is a public domain, multi-sector, partial equilibrium model of the U.S. energy sector[116] that EIA uses to prepare its *AEO*. The FFC factors incorporate losses in production and delivery in the case of natural gas (including fugitive emissions) and additional energy used to produce and

[116] For more information on NEMS, refer to *The National Energy Modeling System: An Overview 2018*, DOE/EIA-0581(2019), April 2019. Available at *www.eia.gov/outlooks/aeo/nems/overview/pdf/0581(2018).pdf* (last accessed July 22, 2024).

deliver the various fuels used by power plants. The approach used for deriving FFC measures of energy use and emissions is described in appendix 10B of the final rule TSD.

At the November 2023 Public Meeting, EEI suggested that DOE consider modifying its analysis to account for the captured energy approach that EIA is now using and/or the zero emissions approach by ASHRAE for noncombustible renewables as alternative FFC factors. (November 2023 Public Meeting Transcript, No. 64 at p. 149) EEI also requested that DOE review the NREL Cambium databases[117] and conduct a sensitivity analysis using alternative FFC factors. (*Id*. at pp. 149-150) With respect to the comment from EEI, it has been DOE's practice for many years to rely on EIA's *AEO* for deriving site-to-primary and FFC energy factors. DOE is aware that, starting with the September 2023 Monthly Energy Review, EIA began converting electricity generation from noncombustible renewables into primary energy using the captured energy approach rather than the fossil fuel equivalency approach that it had previously used. However, the *AEO2023* that DOE used for this final rule still reflects the fossil fuel equivalency approach. DOE will consider conducting a sensitivity analysis using the captured energy approach, as well as a sensitivity analysis using a scenario with a high level of renewable energy market share for any future rulemakings.

In response to the August 2024 NODA, NAMA commented that DOE addressed their request to separate some equipment classes into two categories based on size being above or below 30 cubic feet. (NAMA, No. 112 at pp. 4-5) However, NAMA stated that this change is not reflected in DOE's national impacts analysis to show lesser projected energy savings

[117]See *www.nrel.gov/docs/fy23osti/84916.pdf* for more information (last accessed July 22, 2024). The Cambium datasets include alternative projections on the U.S. electric sector under different scenarios.

for smaller units. *Id.* In response, DOE notes that the energy savings shown in the NIA depend not only on the energy savings of a single unit, but also on its market share and shipment numbers over the analysis period. A unit with lesser energy savings might register higher savings on a national level due to its larger volume of shipments. For example, VCT.SC.M (non-large) is shown to have 0.09 quads of FFC savings while VCT.SC.M (large) is shown to have 0.02 quads of FFC savings at max EL (EL 6) in the August NODA. While the average daily energy consumption of the large representative unit is more than three times higher than that of the non-large representative unit, the ratio of their market shares (shipments) is approximately 1:9.

3. Net Present Value Analysis

The inputs for determining the NPV of the total costs and benefits experienced by consumers are: (1) total annual installed cost, (2) total annual operating costs (which include energy costs and repair and maintenance costs), and (3) a discount factor to calculate the present value of costs and savings. DOE calculates net savings each year as the difference between the no-new-standards case and each standards case in terms of total savings in operating costs versus total increases in installed costs. DOE calculates operating cost savings over the lifetime of equipment shipped during the projection period.

As discussed in section IV.F.1 of this document, DOE developed price trends for CRE of each equipment class containing variable-speed compressors and/or LED lighting. By 2058, which is the end date of the projection period, the average CRE LED lighting price is expected to drop by approximately 25 percent, while the average price of variable-speed compressors is expected to decrease by approximately 85 percent, relative to projected 2029 prices. Because these component prices do not typically contribute substantively to the overall price of equipment, overall equipment prices are projected to decrease by at most 4.0 percent by 2058 relative to 2029. The price of equipment at the current baseline efficiency level is expected to drop by at most 3 percent in the same period. For details on the price learning methodology and assumptions, see chapter 8 of the final rule TSD.

The operating cost savings are energy cost savings, which are calculated using the estimated energy savings in each year and the projected price of the appropriate form of energy. To estimate energy prices in future years, DOE multiplied the average regional energy prices by the projection of annual national-average commercial energy price changes in the Reference case from *AEO2023*, which has an end year of 2050. To estimate price trends after 2050, the 2046–2050 average was used for all years. To estimate repair and maintenance costs, as discussed in section IV.F.5 of this document, DOE considered the typical failure rate of refrigeration system components, component MPCs and associated markups, and the labor cost of repairs. As part of the NIA, DOE also analyzed scenarios that used inputs from variants of the *AEO2023* Reference case that have lower and higher economic growth. Those cases have lower and higher energy price trends compared to the Reference case. In addition, the low economic benefits scenario reflects a no-price-learning approach to calculate the equipment costs. NIA results based on these cases are presented in appendix 10C of the final rule TSD.

In calculating the NPV, DOE multiplies the net savings in future years by a discount factor to determine their present value. For this final rule, DOE estimated the NPV of consumer benefits using both a 3-percent and a 7-percent real discount rate. DOE uses these discount rates in accordance with guidance provided by the Office of Management and Budget ("OMB") to Federal agencies on the development of regulatory analysis.[118] The discount rates for the determination of NPV are in contrast to the discount rates used in the LCC analysis, which are designed to reflect a consumer's perspective. The 7-percent real value is an estimate of the average before-tax rate of return to private capital in the U.S. economy. The 3-percent real value represents the "social rate of time preference," which is the rate at which society discounts future consumption flows to their present value.

a. Sensitivity Analysis for Equipment with Unique Energy Use Characteristics

As discussed in section IV.C.1.c of this document, to account for CRE with certain features (*e.g*., pass-through, sliding door, sliding-door pass-through, roll-in, roll-through, forced-air evaporator, and drawers), DOE applied a single multiplier of 1.07 to the energy use of CRE with these features. To evaluate the impact of such CRE on the NIA, DOE conducted a sensitivity analysis in this final rule and estimated the NES and NPV by applying a 1.07 energy use multiplier to CRE with these features.

Given a lack of market data regarding CRE with these unique energy use characteristics, DOE modeled two sensitivities, each with a different approach to assumptions regarding market shares. In the first approach, DOE relied on CCD model counts to estimate market shares of CRE with unique energy use characteristics. In the

[118] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed Aug. 19, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version. Available at *www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed Aug. 19, 2024).

second approach, DOE assumed that these CRE hold a flat 5 percent market share within their equipment class.

To model this sensitivity, DOE assumed that the efficiency distribution of the equipment with unique features is the same as that of the overall equipment class. DOE assumed an increased energy consumption for the affected equipment by a factor of 7 percent. The results of these sensitivity analyses are shown in Appendix 10C of the final rule TSD.

I. Consumer Subgroup Analysis

In analyzing the potential impact of new or amended energy conservation standards on consumers, DOE evaluates the impact on identifiable subgroups of consumers that may be disproportionately affected by a new or amended national standard. The purpose of a subgroup analysis is to determine the extent of any such disproportional impacts. DOE evaluates impacts on particular subgroups of consumers by analyzing the LCC impacts and PBP for those particular consumers from alternative standard levels. In response to the October 2023 NOPR, an individual commenter submitted a confidential comment that expressed support for the proposed rule but also stated concern that the standards could impose a significant financial burden on small and medium-sized businesses. (Individual Commenter, No. 58 at pp. 1–2) Kirby commented that the proposed purchase prices will limit the growth of small and midsize companies. (Kirby, No. 66 at p. 2) NAMA stated that the cost of the new and amended standards will be significantly higher, with lower energy savings than DOE's estimates, and added that this will affect NAMA's members in "food deserts." (NAMA, No. 85 at p. 2)

For this final rule, DOE analyzed the impacts of the considered standard levels on small businesses. Regarding the comment from NAMA on this rulemaking's impact on "food deserts" (*i.e.*, areas where consumers have limited access to healthy and affordable food options), DOE does not have specific data on the businesses that operate in such areas but assumes that most of them are small businesses. For this subgroup, DOE applied discount rates and electricity prices specific to small businesses to the same consumer sample that was used in the standard LCC analysis. DOE used the LCC and PBP spreadsheet model to estimate the impacts of the considered efficiency levels on these subgroups. Chapter 11 in the final rule TSD describes the consumer subgroup analysis and provides detailed results. See also section V.B.1.b of this document for a summary of the subgroup analysis results.

J. Manufacturer Impact Analysis

1. Overview

DOE performed an MIA to estimate the financial impacts of new and amended energy conservation standards on manufacturers of CRE and to estimate the potential impacts of such standards on employment and manufacturing capacity. The MIA has both quantitative and qualitative aspects and includes analyses of projected industry cash flows, the INPV, investments in research and development ("R&D") and manufacturing capital, and domestic manufacturing employment. Additionally, the MIA seeks to determine how new and amended energy conservation standards might affect manufacturing employment, capacity, and competition, as well as how standards contribute to overall regulatory burden. Finally, the MIA serves to identify any disproportionate impacts on manufacturer subgroups, including small business manufacturers.

The quantitative part of the MIA primarily relies on the GRIM, an industry cash flow model with inputs specific to this rulemaking. The key GRIM inputs include data on the industry cost structure, unit production costs, unit shipments, manufacturer markups, and investments in R&D and manufacturing capital required to produce compliant equipment. The key GRIM outputs are the INPV, which is the sum of industry annual cash flows over the analysis period, discounted using the industry-weighted average cost of capital, and the impact to domestic manufacturing employment. The model uses standard accounting principles to estimate the impacts of more-stringent energy conservation standards on a given industry by comparing changes in INPV and domestic manufacturing employment between a no-new-standards case and the various standards cases (*i.e.*, TSLs). To capture the uncertainty relating to manufacturer pricing strategies following new and amended standards, the GRIM estimates a range of possible impacts under different manufacturer markup scenarios.

The qualitative part of the MIA addresses manufacturer characteristics and market trends. Specifically, the MIA considers such factors as a potential standard's impact on manufacturing capacity, competition within the industry, the cumulative impact of other DOE and non-DOE regulations, and impacts on manufacturer subgroups. The complete MIA is outlined in chapter 12 of the final rule TSD.

DOE conducted the MIA for this rulemaking in three phases. In Phase 1 of the MIA, DOE prepared a profile of the CRE manufacturing industry based on the market and technology assessment and publicly available information. This included a top-down analysis of CRE manufacturers that DOE used to derive preliminary financial inputs for the

GRIM (*e.g.*, revenues; materials, labor, overhead, and depreciation expenses; selling, general, and administrative expenses ("SG&A"); and R&D expenses).

DOE also used public sources of information to further calibrate its initial characterization of the CRE manufacturing industry, including company filings of form 10-K from the SEC,[119] corporate annual reports, the U.S. Census Bureau's *Annual Survey of Manufactures* ("*ASM*"),[120] the U.S. Census Bureau's *Economic Census*,[121] the U.S. Census Bureau's *Quarterly Survey of Plant Capacity Utilization*,[122] and reports from Dun & Bradstreet.[123]

In Phase 2 of the MIA, DOE prepared a framework industry cash-flow analysis to quantify the potential impacts of new and amended energy conservation standards. The GRIM uses several factors to determine a series of annual cash flows starting with the announcement of the standard and extending over a 30-year period following the compliance date of the standard. These factors include annual expected revenues, costs of sales, SG&A and R&D expenses, taxes, and capital expenditures. In general, energy conservation standards can affect manufacturer cash flow in three distinct ways: (1) creating a need for

[119] U.S. Securities and Exchange Commission. *Electronic Data Gathering, Analysis, and Retrieval system*. Available at *www.sec.gov/edgar/searchedgar/companysearch* (last accessed April 11, 2024).

[120] U.S. Census Bureau. *Annual Survey of Manufactures*. (2012–2021). Available at *www.census.gov/programs-surveys/asm/data.html* (last accessed April 11, 2024).

[121] U.S. Census Bureau. *Economic Census*. (2012 and 2017). Available at *www.census.gov/programs-surveys/economic-census.html* (last accessed April 15, 2024).

[122] U.S. Census Bureau. *Quarterly Survey of Plant Capacity Utilization*. (2010–2022). Available at *www.census.gov/programs-surveys/qpc/data/tables.html* (last accessed April 11, 2024).

[123] Dun & Bradstreet Hoovers. Subscription login accessible at *app.dnbhoovers.com/* (last accessed March 15, 2024).

increased investment, (2) raising production costs per unit, and (3) altering revenue due to higher per-unit prices and changes in sales volumes.

In addition, during Phase 2, DOE developed interview guides to distribute to manufacturers of CRE in order to develop other key GRIM inputs, including product and capital conversion costs, and to gather additional information on the anticipated effects of energy conservation standards on revenues, direct employment, capital assets, industry competitiveness, and subgroup impacts.

In Phase 3 of the MIA, DOE conducted structured, detailed interviews with representative manufacturers. During these interviews, DOE discussed engineering, manufacturing, procurement, and financial topics to validate assumptions used in the GRIM and to identify key issues or concerns. As part of Phase 3, DOE also evaluated subgroups of manufacturers that may be disproportionately impacted by new and amended standards or that may not be accurately represented by the average cost assumptions used to develop the industry cash flow analysis. Such manufacturer subgroups may include small business manufacturers, low-volume manufacturers, niche players, and/or manufacturers exhibiting a cost structure that largely differs from the industry average. DOE identified one subgroup for a separate impact analysis: small business manufacturers. The small business subgroup is discussed in section VI.B of this document, “Review under the Regulatory Flexibility Act,” and in chapter 12 of the final rule TSD.

2. Government Regulatory Impact Model and Key Inputs

DOE uses the GRIM to quantify the changes in cash flow due to new or amended standards that result in a higher or lower industry value. The GRIM uses a standard, annual discounted cash-flow analysis that incorporates manufacturer costs, manufacturer markups, shipments, and industry financial information as inputs. The GRIM models changes in costs, distribution of shipments, investments, and manufacturer margins that could result from a new or amended energy conservation standard. The GRIM spreadsheet uses the inputs to arrive at a series of annual cash flows, beginning in 2024 (the base year of the analysis) and continuing to 2058. DOE calculated INPVs by summing the stream of annual discounted cash flows during this period. For manufacturers of CRE, DOE used a real discount rate of 10.0 percent, which was derived from industry financials and then modified according to feedback received during manufacturer interviews.

The GRIM calculates cash flows using standard accounting principles and compares changes in INPV between the no-new-standards case and each standards case. The difference in INPV between the no-new-standards case and a standards case represents the financial impact of the new or amended energy conservation standard on manufacturers. As discussed previously, DOE developed critical GRIM inputs using a number of sources, including publicly available data, results of the engineering analysis, results of the shipments analysis, and information gathered from industry stakeholders during the course of manufacturer interviews and public comments in response to the October 2023 NOPR. The GRIM results are presented in section V.B.2 of this document. Additional details about the GRIM, the discount rate, and other financial parameters can be found in chapter 12 of the final rule TSD.

a. Manufacturer Production Costs

Manufacturing more efficient equipment is typically more expensive than manufacturing baseline equipment due to the use of more complex components, which are typically more costly than baseline components. The changes in the MPCs of covered equipment can affect the revenues, gross margins, and cash flow of the industry. For this final rule, DOE relied on a design-option approach, supported with testing and reverse engineering of directly analyzed CRE, similar to the approach in the August 2024 NODA and October 2023 NOPR. The design options were incrementally added to the baseline configuration and continued through the "max-tech" configuration (*i.e.*, implementing the "best available" combination of available design options).

For a complete description of the MPCs, see section IV.C of this document and chapter 5 of the final rule TSD.

b. Shipments Projections

The GRIM estimates manufacturer revenues based on total unit shipment projections and the distribution of those shipments by efficiency level. Changes in sales volumes and efficiency mix over time can significantly affect manufacturer finances. For this analysis, the GRIM uses the NIA's annual shipment projections derived from the shipments analysis from 2024 (the base year) to 2058 (the end year of the analysis period). See section IV.G of this document and chapter 9 of the final rule TSD for additional details.

c. Product and Capital Conversion Costs

New or amended energy conservation standards could cause manufacturers to incur conversion costs to bring their production facilities and equipment designs into compliance. DOE evaluated the level of conversion-related expenditures that would be needed to comply with each considered efficiency level in each equipment class. For the MIA, DOE classified these conversion costs into two major groups: (1) product conversion costs, and (2) capital conversion costs. Product conversion costs are investments in research, development, testing, marketing, and other non-capitalized costs necessary to make equipment designs comply with new or amended energy conservation standards. Capital conversion costs are investments in property, plant, and equipment necessary to adapt or change existing production facilities such that new compliant equipment designs can be fabricated and assembled.

DOE based its estimates of the product conversion costs that would be required to meet each efficiency level on information obtained from manufacturer interviews; the design pathways analyzed in the engineering analysis; the equipment teardown analysis; the shipments analysis; and model count information. DOE estimated the product development effort—including engineer, laboratory technician, and marketing resources—associated with each design option and scaled the costs based on the number of basic models (or model platforms, depending on the nature of the design option). The product development effort varied by design option. DOE-modeled door design changes (*i.e.*, moving from a double-pane to triple-pane door, incorporating vacuum-insulated glass) would require more complex system redesigns and more cost, as compared to implementing more efficient components (*e.g.*, incorporating a PSC motor or an ECM). DOE also assumed that an additional engineering effort would be required to optimize variable-speed compressors to ensure energy efficiency benefits, based on interview feedback.

To estimate industry product conversion costs, DOE multiplied the product development cost estimate at each efficiency level for each equipment class by the number of industry basic models or equipment platforms that would require redesign. DOE used its CCD[124] and CEC's MAEDbS[125] to identify CRE models covered by this rulemaking. To identify chef bases or griddle stands and high-temperature CRE models, DOE further relied on publicly available data aggregated from the web scraping of retail websites. DOE used the no-new-standards case efficiency distribution from the shipments analysis to estimate the model efficiency distribution for chef bases, griddle stands, and high-temperature CRE. DOE also included the estimated cost of testing to the DOE test procedure for chef bases, griddle stands, and high-temperature units using the estimated per-unit testing cost of $5,000 detailed in the September 2023 Test Procedure Final Rule. 88 FR 66152, 66215.

For this final rule, DOE used its product conversion cost methodology from the October 2023 NOPR and updated data sources from the August 2024 NODA. Specifically, DOE incorporated the most recent Department of Labor's BLS Occupational Employment and Wage Statistics wage data[126] into its product conversion cost estimates and refreshed its

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[124] U.S. Department of Energy's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (last accessed Jan. 31, 2024).
[125] California Energy Commission's Modernized Appliance Efficiency Database System is available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed Jan. 31, 2024).
[126] U.S. Department of Labor, "Occupational Employment and Wage Statistics," (May 2023). Available at *www.bls.gov/oes/2023/may/oes_nat.htm#17-0000* (last accessed May 22, 2024). See National median annual wages for "17-2071 Electrical Engineers," "17-2141 Mechanical Engineers," "17-3027 Mechanical Engineering Technologists and Technicians," and "13-1082 Project Management Specialists."

equipment database to reflect current model listings. Furthermore, in response to stakeholder comments to the October 2023 NOPR regarding the increase in testing and certification costs associated with new safety standards (*i.e*., UL 60335-2-89) and industry test standards (see Hoshizaki, No. 76 at p. 2), DOE doubled product conversion costs associated with UL testing and industry certification for this final rule, consistent with the August 2024 NODA.

In addition to the sources used to derive product conversion costs, DOE relied on additional sources of information such as the Trade Associations Survey,[127] submitted in advance of the October 2023 NOPR, to estimate the capital conversion costs manufacturers would incur to comply with potential new and amended energy conservation standards. During interviews, manufacturers provided estimates and descriptions of the tooling changes required by the considered design options. Based on these inputs, DOE assumed that most component swaps, while requiring moderate product conversion costs, would not require changes to existing production lines or equipment, and, therefore, would not require notable capital expenditures because one-for-one component swaps would not require changes to existing production equipment (*i.e.,* manufacturers will continue to be able to use their existing production equipment and production lines to manufacture CRE that achieve higher efficiency levels through component swaps, which are typically associated with lower efficiency levels). However, based on manufacturer feedback, DOE modeled some tooling and capital expenditures when manufacturers implement improved door designs and variable-speed compressors. For improved door designs, some manufacturers noted that they would need new fixtures. Incorporating additional panes of glass for high-volume equipment

[127] *See* Trade Associations Survey, No. 50 at pp. 16–18. Available at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0050.*

classes could also necessitate heavier duty lifting equipment to transport and assemble heavier glass packs. For variable-speed compressors, which could be larger than existing single-speed compressors, manufacturers may need new tools for the baseplate. To estimate industry capital conversion costs, DOE scaled the estimated capital expenditures at each efficiency level for each equipment class by the number of applicable OEMs.

As previously stated, the Trade Associations Survey included information about the anticipated capital investments associated with a range of design options. (Trade Association Survey, No. 50 at pp. 16–18) The survey results showed high capital investments associated with increasing insulation thickness and incorporating vacuum-insulated panels. (*Id*. at p. 18) As discussed in section IV.B.1 of this document, DOE excluded these technologies from further consideration in the engineering analysis. Other design options potentially requiring notable capital investment included microchannel condensers, additional panes of glass, and variable-speed compressors. Although DOE analyzed microchannel condensers as a design option to improve efficiency in the October 2023 NOPR, DOE notes that it did not analyze microchannel condensers as a design option in the August 2024 NODA or this final rule analysis. DOE compared feedback from the Trade Associations Survey with information from the equipment teardown analysis and manufacturer interviews and incorporated the feedback where applicable.

Consistent with the August 2024 NODA, DOE adjusted its capital conversion cost estimates from 2022$ to 2023$ for this final rule but otherwise maintained its capital conversion cost methodology from the October 2023 NOPR.

In general, DOE assumes all conversion-related investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new standard. The conversion cost figures used in the GRIM can be found in section V.B.2.a of this document. For additional information on the estimated capital and product conversion costs, see chapter 12 of the final rule TSD.

d. Manufacturer Markup Scenarios

MSPs include direct manufacturing production costs (*i.e.*, labor, materials, and overhead estimated in DOE's MPCs) and all non-production costs (*i.e.*, SG&A, R&D, and interest), along with profit. To calculate the MSPs in the GRIM, DOE applied manufacturer markups to the MPCs estimated in the engineering analysis for each equipment class and efficiency level. Modifying these manufacturer markups in the standards case yields different sets of impacts on manufacturers. For the MIA, DOE modeled two standards-case scenarios to represent uncertainty regarding the potential impacts on prices and profitability for manufacturers following the implementation of new and amended energy conservation standards: (1) a preservation-of-gross-margin-percentage scenario, and (2) a preservation-of-operating-profit scenario. These scenarios lead to different manufacturer markup values that, when applied to the MPCs, result in varying revenue and cash flow impacts.

Under the preservation-of-gross-margin-percentage scenario, DOE applied a single uniform "gross-margin percentage" across all efficiency levels and equipment classes, which assumes that manufacturers would be able to maintain the same amount of profit as a percentage of revenues at all efficiency levels within an equipment class. As manufacturer production costs increase with efficiency, this scenario implies that the per-unit dollar profit will increase. In the October 2023 NOPR, DOE used a gross-margin percentage of 29 percent for all equipment classes.[128] 88 FR 70196, 70247. In the August 2024 NODA and this final rule, DOE used a gross-margin percentage of 28 percent for all equipment classes based on comments in response to the October 2023 NOPR and market share weights.[129] Manufacturers tend to believe it is optimistic to assume that they would be able to maintain the same gross-margin percentage as their production costs increase, particularly for minimally efficient equipment. Therefore, this scenario represents a high bound of industry profitability under new and amended energy conservation standards. To address manufacturer concerns about reduced margins and profitability under potential amended standards, DOE also analyzes a preservation-of-operating-profit scenario.

Under the preservation-of-operating-profit scenario, as the cost of production goes up under a standards case, manufacturers are generally required to reduce their manufacturer markups to a level that maintains base-case operating profit. DOE implemented this scenario in the GRIM by lowering the manufacturer markups at each TSL to yield approximately the same earnings before interest and taxes in the standards case as in the no-new-standards case in the year after the expected compliance date of the new and amended standards. The implicit assumption behind this scenario is that the industry can only maintain its operating profit in absolute dollars after the standard takes effect.

[128] The gross-margin percentage of 29 percent is based on a manufacturer markup of 1.40.
[129] The gross-margin percentage of 28 percent is based on a manufacturer markup of 1.38.

A comparison of industry financial impacts under the two manufacturer markup scenarios is presented in section V.B.2.a of this document.

3. Discussion of MIA Comments

a. Conversion Costs

In response to the October 2023 NOPR, NAMA commented the industry would incur hundreds of thousands to millions in capital costs when incorporating increased insulation, VIPs, heavier doors, and microchannel coils, which will take place in an environment with rising interest rates. (NAMA, No. 85 at p. 10) NAMA requested that DOE consider fully burdened conversion costs for the following areas: mold cost for plastic parts; production of the molds in molding machines; fixtures for production of metal parts; fixtures to hold the components in place; engineering design changes; manufacturing changes; building of prototypes to test internally; testing of prototypes; building of pre-production units from production parts and fixtures (sometimes called a pilot lot); safety certification for pre-production units; safety certification costs from U.S. Department of Labor Occupational Safety and Health Administration ("OSHA") nationally recognized test laboratories ("NRTLs"); internal costs for performance testing; external costs for performance testing; internal energy testing; energy testing from outside laboratories for confirmation; training of production employees; training of service personnel; equipment for service personnel; and capital costs amortized over 3 to 5 years. (*Id*. at p. 22)

NAFEM stated some CRE models can be redesigned to achieve a lower energy limit within the 3-year timeline, while others (primarily self-contained products) have unknown design challenges and variable-speed evaporators and/or condenser fan motors and variable-speed compressors and all the extra electronic controls required for these variable-speed components will require extensive testing to accommodate the proposed limits to increase energy efficiency. (NAFEM, No. 83 at p. 12)

AHRI commented that microchannel condensers should include supplier tooling costs, existing and potential tariffs, laboratory testing, field testing, product line changeovers, refrigerant charge, and air flow analysis. (AHRI, No. 81 at p. 12) Hoshizaki commented that changing condensers requires manufacturers to purchase new jigs for brazing patterns where the cost of the jigs depends on the size and complexity. (Hoshizaki, No. 76 at p. 5) Hoshizaki stated jigs for brazing can cost thousands and costs for new condensing units are amortized over the first 3 years of purchase. (*Id*.) Hoshizaki commented that there are increased labor costs for variable-speed compressors because they require fine-tuning of design controls for optimum energy use. (*Id*.)

NAFEM commented that each foam fixture can cost between $250,000 and $750,000 depending on size and complexity, so new foam fixtures are multi-million-dollar investments. (NAFEM, No. 83 at p. 19) NAFEM also stated complex control systems require wiring, sensors, and additional assembly. (*Id*.)

In response to these comments, DOE notes that it incorporates investments in research, development, testing and certification, marketing, and other non-capitalized costs necessary to make equipment designs comply with standards (*i.e.*, product conversion costs) and investments in property, plant, and equipment necessary to adapt or change existing production facilities (*i.e.*, capital conversion costs) into its MIA. For the October 2023

NOPR, DOE analyzed incorporating a range of design options, including microchannel condensers, variable-speed compressors, and improved door designs (*i.e.*, moving to double-pane, triple-pane, or vacuum-insulated glass for CRE equipment classes with transparent doors). However, DOE did not consider increased insulation thickness or VIPs as design options in its engineering analysis as DOE had tentatively screened out those technology options due to "impacts on product utility". See section IV.B of this document for additional information.

For this final rule, DOE maintains the approach used in the August 2024 NODA. Specifically, based on stakeholder comments to the October 2023 NOPR, DOE revised its baseline component assumptions and revised its assessment of representative insulation thickness for the August 2024 NODA and this final rule to align with the insulation thickness assumptions used in the March 2014 Final Rule.[130] As such, DOE did not incorporate estimates associated with increasing insulation thickness or VIPs in its conversion costs for this final rule. As discussed in section IV.B.1.g of this document, DOE screened out the use of microchannel condensers as a design option to improve efficiency in this final rule analysis. Thus, consistent with the August 2024 NODA, DOE does not consider investments associated with implementing microchannel condensers in its MIA for this final rule. Consistent with both the August 2024 NODA and 2023 October NOPR, DOE assumed that implementing variable-speed compressors takes an additional level of engineering effort and testing time compared to other design options based on manufacturer feedback from

[130] 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*. DOE updated the following insulation thicknesses: 1.5 in. for medium- and high-temperature equipment, 2.0 in. for low-temperature equipment, and 2.5 in. for ice-cream temperature equipment. Table IV.11 in this document.

confidential interviews. See chapter 12 of the final rule TSD for industry conversion costs by efficiency level for each directly analyzed equipment class.

Hussmann commented that design changes may lead to incorporating additional components (*e.g.*, EEVs, case controllers, lighting controls, anti-sweat heater controllers), which would negatively impact production rates and plant capacity if equipment becomes more difficult to assemble. (Hussmann, No. 80 at p. 8) Hussmann and AHRI commented that manufacturers would also have to develop new training materials and programs to educate existing technicians on the integration of these additional electronic components. (*Id*. at p. 8; AHRI, No. 81 at p. 10)

DOE understands that incorporating additional components could require additional sub-assembly stations and increase per-unit production time, potentially impacting plant capacity. DOE clarifies that EEVs, case controllers, and anti-sweat heater controls are not design options analyzed in this final rule, although DOE understands that manufacturers can choose to meet the adopted standards using a variety of different technologies. Furthermore, DOE does not expect that TSL 3 efficiencies would necessitate the use of occupancy sensors with dimming capability. Additionally, DOE notes that manufacturers have 4 years after this final rule publishes in the *Federal Register* to update CRE designs and production facilities to comply with the adopted standards. As such, DOE does not expect the CRE industry would face long-term capacity constraints as a direct result of the standards adopted in this final rule. As discussed in section V.B.2.c of this document, DOE assesses potential impacts of standards on manufacturing capacity. Manufacturers primary concern was about the dual development needed to comply with both new and amended energy conservation standards and EPA refrigerant regulations over a similar timeframe, however, DOE expects that extending the compliance period from the 3-years analyzed in the October 2023 NOPR to 4-years in this final rule will help mitigate these concerns about laboratory and engineering resource constraints. Regarding developing new training material for technicians, DOE's product conversion costs are intended to encompass investments in marketing and other non-capitalized expenses that directly result from meeting new or amended standards.

NAMA commented that DOE's consultants did not account for the enormous capital costs of most design options or the enormous cumulative burden that results from the transition from high-GWP refrigerants to low-GWP refrigerants. (NAMA, No. 85 at p. 10) NAMA also commented that the practice of burying capital costs in a separate category and not accounting for them in the true cost of design options is unrealistic. (*Id*. at p. 11)

In response to the comment from NAMA, DOE notes that it accounts for the capital investments required to implement the design options analyzed in the engineering analysis in its industry cash flow model, the GRIM. DOE also notes that it does not expect manufacturers would incur significant capital conversion costs as a result of the standards in this final rule as DOE is not analyzing capital-intensive design options such as increasing insulation thickness or implementing VIPs in its analysis. See section IV.J.2.c of this document for a discussion of conversion cost methodology and section V.B.2.a of this document for estimated capital conversion costs required to meet each TSL.

Regarding DOE's accounting of the investments required to transition to low-GWP refrigerants in response to Federal and State regulations, DOE accounts for the investments required to transition to low-GWP refrigerants in its GRIM in the no-new-standards case and standards case. DOE did not consider these investments as "conversion costs" as they are considered as part of the analytical baseline. In other words, the CRE industry would incur refrigerant transition expenses to comply with the October 2023 EPA Final Rule regardless of whether DOE amends energy conservation standards for CRE. Although refrigerant transition costs are not attributable to this DOE rulemaking, DOE incorporates these expenses into its GRIM to better reflect the state of industry finances and annual cash flow.

For the October 2023 NOPR, DOE relied on manufacturer feedback in confidential interviews, a report prepared for EPA,[131] results of the engineering analysis, and investment estimates submitted by NAMA and AHRI in response to the June 2022 Preliminary Analysis to estimate the industry refrigerant transition costs. 88 FR 70196, 70284. Based on feedback, DOE assumed that the transition to low-GWP refrigerants would require industry to invest approximately $21.3 million in R&D and $33.3 million in capital expenditures (*e.g.*, investments in new charging equipment, leak detection systems, *etc.*) from 2023 to 2025.[132] *Id*. DOE estimates industry would incur approximately $13.6 million in R&D and $17.7 million in capital expenditures from 2024 to 2027 for this final rule.[133] These values reflect the estimated refrigerant transition expenses incurred during the period analyzed in this final rule (*i.e.*, 2024–2058), and not the cumulative industry investments associated with

[131] See pp. 5–113 of the "Global Non-CO_2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation" (2019). Available at *www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf*.
[132] At the time of the October 2023 NOPR analysis, the December 2022 EPA NOPR proposed a compliance date of January 1, 2025 for all subsectors relevant to CRE covered by this rulemaking.
[133] The October 2023 EPA Final rule maintained a January 1, 2025 compliance date for stand-alone units but delayed compliance to January 1, 2026 or January 1, 2027 for other subsectors relevant to CRE covered by this rulemaking.

transitioning to low-GWP refrigerants. DOE addresses stakeholder comments about the costs associated with the refrigerant transition in section IV.J.3.f of this document. These stakeholder comments relate to concerns about underestimating the costs associated with the refrigerant transition. For more detailed information on how DOE accounts for the refrigerant transition in its MIA, see section V.B.2.e of this document.

NAFEM asserted that DOE did not account for the substantial and unprecedented inflation and cost-of-capital issues that are plaguing all private enterprise at this time, including the CRE industry, in its October 2023 NOPR. (NAFEM, No. 83 at p. 14) NAFEM emphasized that the current macroeconomic environment makes short-term or long-term borrowing for capital improvements impossible. (*Id*. at p. 17) NAMA similarly commented that high interest rates make large investments—such as the expenses required to transition to low-GWP refrigerants in response to Federal and State refrigerant regulation—very expensive. (NAMA, No. 85 at p. 3)

For the October 2023 NOPR, DOE used the discount rate (*i.e*., the weighted average cost of capital) from the March 2014 Final Rule as a starting point for the MIA. The March 2014 Final Rule financial parameters were vetted by multiple manufacturers in confidential interviews and went through public notice and comment. DOE then compared the discount rate developed for the prior CRE rulemaking to recent financial data from four publicly traded CRE manufacturers to ensure relevance. DOE presented the discount rate and other financial parameters to manufacturers during confidential interviews conducted in January 2023 in advance of the October 2023 NOPR. See chapter 12 of the October 2023 NOPR

TSD.[134] Based on feedback, DOE used a discount rate of 10.0 percent in its MIA conducted for the October 2023 NOPR. 88 FR 70196, 70246. As DOE did not receive quantitative feedback from manufacturers on the discount rate in response to the October 2023 NOPR, DOE maintained a discount rate of 10.0 percent for the August 2024 NODA and for this final rule. Regarding DOE's accounting of inflation, for this final rule, DOE updated its engineering analysis to incorporate up-to-date cost estimates by way of 5-year moving averages for materials and the most up-to-date costs for purchased parts.

In response to the October 2023 NOPR, Hillphoenix commented that the standards proposed in the October 2023 NOPR, if adopted, would force OEMs to discontinue equipment, noting that the March 2014 Final Rule standards (which went into effect in 2017) eliminated less-efficient models that were offered as part of tiered efficiency-based pricing. (Hillphoenix, No. 77 at p. 1) In response to the October 2023 NOPR and August 2024 NODA, Hillphoenix commented that proposed standards may lead to equipment commoditization where equipment can only compete on price rather than value-added options and features. (Hillphoenix, No. 77 at p. 1; Hillphoenix, No. 110 at p. 1) In response to August 2024 NODA, Hillphoenix similarly commented that the proposed standards would force OEMs to discontinue models, which would have negative business impacts, stifle innovation, lead to commoditization, and lead to a disadvantage selling in foreign markets. (Hillphoenix, No. 110 at p. 1)

[134] Available at *www.regulations.gov/document/EERE-2017-BT-STD-0007-0051*.

With respect to the comment from Hillphoenix, DOE acknowledges that not all models on the market would meet the efficiency levels proposed in the October 2023 NOPR or the efficiency levels adopted in this final rule. As discussed in section IV.J.2.c of this document, DOE used its CCD as a key input to its conversion cost methodology to estimate the number of unique basic models that would require redesign for each directly analyzed equipment class at each efficiency level. To avoid underestimating the potential investments, DOE assumed manufacturers would redesign all models that would not currently meet each analyzed efficiency level. As such, industry conversion costs reflect the redesign effort required to update the portion of CRE models that do not meet each efficiency level.

In the October 2023 NOPR, DOE estimated that approximately 11 percent of shipments would meet the proposed levels by the analyzed compliance year. However, DOE estimates that approximately 49 percent of shipments would meet the levels adopted in this final rule (*i.e.*, TSL 3). Therefore, compared to the October 2023 NOPR, fewer models would require redesign to meet the adopted TSL in this final rule. Furthermore, compared to the October 2023 NOPR, manufacturers will have an additional year to redesign CRE to meet new and amended standards. Based on stakeholder feedback, DOE is extending the compliance period from the 3 years analyzed in the October 2023 NOPR to 4 years. DOE also notes that in the October 2023 NOPR, DOE proposed energy use multipliers for certain features (*e.g.*, pass-through doors, sliding doors, roll-in doors, roll-through doors, and forced air evaporators). 88 FR 70196, 70231. As presented in the August 2024 NODA, in this final rule, DOE is adopting a simplified multiplier of 1.07 to the eligible equipment classes discussed in the October 2023 NOPR. See section IV.C.1.a of this document for a discussion of equipment classes with unique energy use characteristics. As such, DOE expects that these types of features and others would remain prevalent in the market and could offer means for equipment differentiation, minimizing the risk of equipment commoditization. Additionally, DOE notes that it is not adopting the max-tech efficiency level for most directly analyzed equipment classes. Out of the 28 directly analyzed equipment classes, DOE is adopting efficiency levels below max-tech for 18 classes, which account for approximately 84 percent of industry shipments covered by this rulemaking. DOE expects that manufacturers would still be able to differentiate their models and product lines by various factors (*e.g.*, price, technologies, consumer features, energy efficiency) rather than just price as Hillphoenix contended in its comment. Furthermore, as discussed in section IV.C.1.b of this document, there are a range of models on the market and certified in DOE's CCD that exceed the analyzed max-tech efficiency levels. Possible explanations for the variability in energy usage could be due to a range of lighting powers, differences in insulation thickness, and use of evaporator fan controls, among other reasons.

b. Impacts on Direct Employment

In response to the October 2023 NOPR, Continental commented it may discontinue equipment, potentially affecting Continental employees, if the standards proposed in the October 2023 NOPR were implemented. (Continental, No. 86 at p. 6) AHRI commented that proposed standards in the October 2023 NOPR would force domestic manufacturers to exit the market, effectively lessening consumer choice. (AHRI, No. 81 at p. 15) NAMA commented that a large CRE manufacturer recently closed a factory and reduced company output, resulting in job loss. (NAMA, No. 85 at p. 4)

NAFEM added that the costs and complexity of adopting technology like variable-speed compressors would lead to cost and price increases, which in turn would impede the ability to compete against other equipment, particularly from foreign manufacturers who benefit from government subsidies. (NAFEM, No. 83 at p. 18) NAFEM commented its members continue to share their concerns about the substantial manufacturing costs and investments necessary to comply with the October 2023 NOPR. (*Id*. at p. 19)

In response to the August 2024 NODA, Delfield commented that if standards reduce equipment offerings, manufacturers may reduce their workforce, negatively impacting local communities where manufacturers are major employers. (Delfield, No. 99 at p. 1)

With respect to these comments, DOE notes that it analyzes the potential impacts to domestic manufacturing employment in section V.B.2.b of this document. DOE's direct employment analysis explores the potential reduction in employment under the standards cases (*i.e.*, each TSL) relative to the estimated employment absent standards (*i.e.*, the no-new-standards case). As discussed in section V.B.2.b of this document, DOE estimates that the potential change in domestic direct employment could range from -4,404 to -93 in 2029 at TSL 3. The upper bound of domestic employment represents the potential change in domestic production and non-production workers if manufacturers continue to produce the same scope of CRE in the United States after compliance. The lower bound estimate conservatively assumes that some domestic manufacturing either is eliminated or moves abroad at more stringent efficiency levels. DOE estimates that approximately 77 percent of CRE covered by this rulemaking are produced domestically. DOE notes that, compared to the October 2023 NOPR, the levels adopted are less stringent (in terms of percent energy use reduction from the analyzed baseline) for 22 out of the 28 directly analyzed equipment classes. These 22 equipment classes account for approximately 96 percent of industry shipments covered by this final rule. In the October 2023 NOPR, DOE estimated that approximately 11 percent of CRE shipments would meet the proposed standards by 2028, a year before the analyzed compliance year. Comparatively, DOE estimates that approximately 49 percent of CRE shipments would meet the standards adopted in this final rule by the analyzed compliance date. Based on a review of its CCD and market research conducted in support of its direct employment analysis, DOE understands that a range of OEMs with domestic CRE manufacturing facilities already offer models that meet the efficiency levels adopted in this final rule. Specifically, DOE identified 30 OEMs with domestic manufacturing facilities that sell the five highest shipments volume equipment classes (VCS.SC.L, VCS.SC.M, VCT.RC.M, VCT.SC.L, and VCT.SC.M). Of those 30 OEMs, only 3 manufacturers do not have any models that meet TSL 3. Approximately half of these 30 OEMs, including the largest CRE manufacturer (in terms of sales volume), currently make CRE exclusively in domestic production facilities.

c. Laboratory Resource Constraints

In response to the October 2023 NOPR, NAFEM, Hoshizaki, SCC, Hillphoenix, Hussmann, and AHRI all expressed concerns that third-party laboratories already have backlogs and are experiencing delays, meaning that new and amended standards for CRE could exacerbate the issue and require more internal testing and third-party testing. (NAFEM, No. 83 at pp. 12–13; Hoshizaki, No. 76 at p. 2; SCC, No. 74 at p. 1; Hillphoenix, No. 77 at p. 3; Hussmann, No. 80 at p. 1; AHRI, No. 81 at p. 2) SCC stated that there is a 3-to-6-month backlog at NRTLs from the October 2023 EPA Final Rule and UL safety standards. (SCC, No. 74 at p. 1) SCC commented that estimates are up to several years just for certification of a manufacturer's full catalog, and testing for UL 60335-2-89 will extend the time needed to test and comply for each CRE model family using new refrigerants. (*Id*. at pp. 1, 2)

In response to the August 2024 NODA, Hussmann commented amendments to UL/CSA 60335-1 and 60335-2-89 requires critical resources, laboratory space, and time. Hussmann stated that these amendments would potentially extend UL approval time by up to 14 weeks. (Hussmann, No. 108 at p. 2) In response to the October 2023 NOPR and August 2024 NODA, Hussmann commented that the backlog at NRTLs will lead to certification delays both for its equipment and components from its suppliers. (Hussmann, No. 80 at p. 1; Hussmann, No. 108 at p. 1) Hillphoenix stated that changes to CRE designs require OEMs to retest to standards from DOE, UL, NSF, ASHRAE, and AHRI. (Hillphoenix, No. 77 at p. 3) In response to the August 2024 NODA, Hillphoenix commented the industry is concerned with the availability of NRTLs to meet proposed standard, regulations from EPA AIM Act, and safety standard UL 60335-2-89, and manufacturers are using significant portions of engineering, supply chain resources, manufacturing, and marketing to meet regulations. (Hillphoenix, No. 110 at p. 2) In response to the October 2023 NOPR, Hoshizaki commented that the refrigerant changes required by 2026, energy conservation standards for ACIMs and CRE by 2027–2028, the new UL safety standard, and NSF sanitation testing for new ice-making systems will push its testing laboratories to capacity, requiring Hoshizaki to rely on third-party laboratories for safety testing. (Hoshizaki, No. 76 at p. 6)

AHRI stated that manufacturers are currently switching to low-GWP refrigerants, and DOE rulemakings increase pressure on laboratory availability, testing capacity, and component availability. (AHRI, No. 81 at p. 2) AHRI stated manufacturers are facing regulatory burdens of DOE rulemakings for ACIMs and WICFs, the October 2023 EPA Final Rule, UL 60335-89-2 and UL 60335-4-40 safety standards, and PFAS regulations, all of which constrain manufacturers' engineering resources, testing validation, verification time, and sourcing components, and constrain independent laboratory testing from low-GWP refrigerants. (*Id*. at pp. 2, 5) AHRI further asserted that EPA and DOE rulemakings regulations pose a high risk for manufacturers to be unable to meet all requirements in the required timeframes. (*Id.* p. 2) AHRI commented that conversion of CRE to larger refrigerant charges over 150 grams is a significant, design-intensive process spanning multiple years and requiring project management, product management, industrial engineering, maintenance, quality, finance, marketing, design engineering, and compliance. (*Id*. at p. 14) AHRI commented that, as of September 29, 2024, new CRE can only be certified to UL 60335-2-89 and any significant equipment modifications for each model family must be certified to UL 60335-2-89—including to CRE using A2L refrigerant or an A3 refrigerant with charge larger than 150 grams. (*Id*. at pp. 2, 5) AHRI stated that manufacturers' third-party national laboratories for UL 60335-2-89 require special sensory equipment that will further limit laboratory capabilities and double the testing time of larger units. (*Id.* at p. 14) Specifically, AHRI commented that laboratory testing time for larger-charged units will double from less than 1 week to nearly 2 weeks, with additional testing required, including end-use lower-flammability limit component testing, annex CC testing, and vibration testing. (*Id*. pp. 14–15)

Hoshizaki commented that UL safety standard 60335-2-89 requires extensive review of refrigeration equipment, which will increase testing and approval time for each model. (Hoshizaki, No. 76 at p. 2) Hoshizaki elaborated that manufacturers will need more testing equipment, testing time, and training for engineers. (*Id*.) Hoshizaki commented that changes to safety and energy testing have more than doubled the testing time for each model family as a result of UL safety standards, Intertek safety certification, and ASHRAE 29 and 72 standards. (*Id*. at p. 6) Hoshizaki requested that DOE investigate if NRTLs are expanding to meet the higher testing demand for the use of flammable refrigerants. (*Id*.) Hoshizaki commented that manufacturers will need additional time to complete all the necessary testing involved for CRE that require redesign as a result of new and amended standards due to the existing "backlog" of third-party laboratories. (*Id.* at pp. 1–2) Hoshizaki commented that more than 100 of its CRE models will 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. (*Id.* at pp. 6–7) In response to the August 2024 NODA, NAMA acknowledged DOE's assessment of the increased testing costs associated with new UL safety standards. (NAMA, No. 112 at p. 5) NAMA asserted that the cost of DOE testing for energy efficiency will increase noting that 2 units need to be tested. (*Id* at p. 6).

Hussmann commented that compliance to UL 60335-2-89 uses critical resources, laboratory space, and time for new components and design modifications. (Hussmann, No. 80 at p. 2) Hussmann asserted that its testing laboratories and personnel are at capacity. (*Id*. at p. 1) In the October 2023 NOPR and August 2024 NODA, Hussmann commented manufacturers will commit 1 to 3 years of laboratory time and significant resource investment to test to UL standards when evaluating the performance of new A3 or A2L components from the October 2023 EPA Final Rule. (*Id.* at p. 2; Hussmann, No. 108 at p. 1) Hillphoenix commented that UL 60335-2-89 requires all new CRE to be certified if using most end-uses of A2Ls and larger charges or R-290, which requires more testing, equipment markings, instructions, and modifications to meet the safety requirements. (Hillphoenix, No. 77 at p. 3) Hillphoenix commented that UL 60335-2-89 requires significantly more testing potentially and substantial modifications to meet the safety requirements. (*Id.*) Hillphoenix commented that each time equipment changes, OEMs must retest to all of these regulations and specific test standards, and there is substantial industry concern over the availability of NRTLs to meet the evolving regulatory landscape. (*Id.*) Hillphoenix stated that a significant portion of engineering, supply chain, manufacturing, and marketing resources are being consumed just to meet these evolving regulations. (*Id.*)

NAFEM commented that the standards proposed in the October 2023 NOPR would require extensive testing for the CRE industry, which is problematic due to bottlenecks related to changing safety and environmental regulations at third-party testing laboratories. (NAFEM, No. 83 at p. 12)

With respect to these comments, DOE understands that complying with concurrent EPA and DOE regulations, compounded by changes to UL safety standards and industry test standards, requires a significant amount of engineering and laboratory resources for CRE manufacturers. Regarding the redesign, testing, and certification required to develop CRE designs that comply with the October 2023 EPA Final Rule, DOE accounts for those refrigerant transition expenses incurred during the analysis period (2024 to 2058) in its MIA.

DOE recognizes that many CRE manufacturers also manufacture WICFs and ACIMs, as shown in Table V. in section V.B.2.e of this document. DOE notes that the compliance dates in the October 2023 EPA Final Rule are staggered for these equipment categories across multiple years, rather than having a single January 1, 2025 compliance date as proposed in the December 2022 EPA NOPR. Staggering compliance dates could lessen potential bottlenecks in the transition to manufacture new equipment, such as testing and certification of equipment by an NRTL. See 88 FR 73098, 73133. For WICFs, the October 2023 EPA Final Rule established GWP restrictions for refrigeration systems with remote condensing units in retail food refrigeration systems and cold storage warehouses with less than 200 pounds ("lbs") of charge, effective January 1, 2026. See *id*. at 88 FR 73209. The October 2023 EPA Final Rule established GWP restrictions for ACIMs effective January 1, 2026 or January 1, 2027, depending on the ACIM equipment category. See *id*. at 88 FR 73165. Regarding potential DOE standards for WICFs and ACIMs, DOE notes that it issued a final rule amending standards for WICFs on November 29, 2024, with compliance required for WICF refrigeration systems starting December 31, 2028 (approximately 1 year later than what was proposed, see 88 FR 60746).[135] At this time, DOE has proposed but has not finalized new and amended standards for ACIMs. See 88 FR 30508. In this final rule, DOE is adopting a 4-year compliance period (modeled as a 2029 compliance year), providing manufacturers an additional year compared to the October 2023 NOPR to complete the necessary testing and redesign needed to meet the adopted standards. As such, DOE expects

[135] At the time of issuance of this final rule, the WICFs final rule has been issued and is pending publication in the *Federal Register.* Once published, the final rule pertaining to WICFs will be available at: *www.regulations.gov/docket/EERE-2017-BT-STD-0009.*

that any energy conservation standards compliance dates for CRE, WICFs, and ACIMs (should DOE adopt more stringent standards) will be staggered.

Regarding stakeholders' comments on the increase in per-unit testing burden as a result of the transition to UL 60335-2-89, DOE updated its product conversion costs to reflect the increase in testing burden. As discussed in section IV.J.2.c of this document, DOE doubled the costs associated with testing and certifying to the new UL safety standard in response to written comments and secondary research.

d. Supply Chain

In response to the October 2023 NOPR, NAMA asserted that DOE has not addressed the lack of available components in the supply chain. (NAMA, No. 85 at p. 15) Hoshizaki, Hussmann, and AHRI commented that manufacturers experience long lead times and shortages of components, including electronic controls, fan motors, compressors, sheet metal, and plastic resin. (Hoshizaki, No. 76 at pp. 5–6; Hussmann, No. 80 at p. 13; AHRI, No. 81 at pp. 12-13) Hussmann and AHRI commented that COVID-19 impacted the supply chain for computer chips and, while the situation is improving, shortages and long lead times for electrical components, materials, and parts remain. (Hussmann, No. 80 at p. 13; AHRI, No. 81 at pp. 12–13) In response to the August 2024 NODA, Hussmann commented that the industry faces supply chain issues related to A2L components, standard supply chain issues prevalent since COVID-19, time constraints, resource constraints, and laboratory capacity limitations, and a learning curve to understand new baseline energy usage. (Hussmann, No. 108 at p. 2) In response to the October 2023 NOPR, AHRI commented that supply chain issues for electrical components requires that CRE OEMs continually redesign equipment to adapt to new electronic controls. (AHRI, No. 81 at p. 13) AHRI added that manufacturers experience high component prices; uncertainty around PFAS regulations; long lead times for variable-speed compressors, variable-speed fans, variable-speed drives, system controllers, and ECMs; electronic component redesign; backlogs for components to certify to both UL 60335-2-40 and UL 60335-2-89; time for sourcing alternative components; and additional reliability testing of new components. (*Id.*)

Hussmann commented that electronic component shortages forced a supplier to discontinue several fan motors and assemblies, abandon adjustable-speed motors in "Insight Merchandisers",[136] and source EEVs and case controllers, taking several months, which constrains engineering resources. (Hussmann, No. 80 at p. 13) Hussmann also commented that computer chips and controller shortages have resulted in $10,000 in laboratory costs to conduct reliability testing, performance validation testing on CRE cases, and UL and NSF testing and validation. (*Id.* at pp. 1, 13) Hussmann stated that more shortages may occur if more controllers or computer chips are required to meet proposed standards, particularly if the United States imposes a ban on semi-conductors from China (Section 5949 of the National Defense Authorization Act). (*Id.* at p. 13)

In response to the August 2024 NODA, Delfield commented the proposed standards would have a significant impact on manufacturers in terms of testing, development, and overall business resources, which may negatively impact equipment availability. (Delfield, No. 99 at p. 1) Delfield stated that if the supply chain is not equipped for all most

[136] *www.hussmann.com/en/products/display-cases/insight-merchandisers#p=48*. (Last accessed October 8, 2024)

manufacturers to move to new tooling and components, it could result in production delays. (*Id.*)

In response to comments about supply chain issues, DOE notes that for the August 2024 NODA and this final rule, DOE updated its engineering analysis to incorporate up-to-date cost estimates. Increased costs associated with recent supply chain challenges stemming from the COVID-19 pandemic have been incorporated into the cost analysis by way of 5-year moving averages for materials and up-to-date costs for purchased parts. DOE expects manufacturers would most likely incorporate design options that require more electronic components (*e.g.*, ECMs, variable-speed compressors) to meet the standards adopted in this final rule. However, based on the engineering and teardown analyses as well as comments from manufacturers (see AHRI, No. 81 at pp. 4–5; Delfield, No. 71 at p. 1; Hussmann, No. 80 at p. 10), DOE understands that the use of advanced electronics (*e.g*., EC fan motors and controls for fans) is already prevalent in the CRE industry. For this final rule, DOE expects that 10 directly analyzed equipment classes, which account for 50 percent of self-contained CRE shipments (approximately 43 percent of total industry shipments), would likely need to incorporate variable-speed compressors to meet TSL 3. However, for those 10 equipment classes, 30 percent of shipments already meet TSL 3 efficiencies. Additionally, as discussed in section III.A.2.a of this document, DOE is extending the compliance period from 3-years analyzed in the October 2023 NOPR to 4-years for this final rule. The 4-year compliance period provides some economic and regulatory certainty to component suppliers and manufacturers, which eases supply constraints on components that manufacturers may need in order to meet the new and amended standards.

e. Cumulative Regulatory Burden

In response to the October 2023 NOPR, AHRI appreciated that DOE recognizes the cumulative regulatory burden associated with regulatory initiatives of multiple Federal agencies and standards-setting bodies, which includes DOE energy conservation standards for CRE, WICF, and ACIM rulemakings occurring simultaneously with refrigerant regulation such as the October 2023 EPA Final Rule, and changes to UL safety standards, State regulations, *etc*. (AHRI, No. 81 at pp. 13–14) AHRI commented that all these regulatory actions entail costs, engineering design time, testing validation and verification time, establishment of new supply chains, and independent laboratory testing. (*Id*. at p. 14) AHRI commented also that DOE's proposed changes to medium electric motors and expanded-scope electric motors ("ESEMs")—formerly named small non-small electric motors—in 2027 would also have an impact on CRE manufacturers and may require equipment changes to account for larger motors, additional testing, safety agency approval, backward compatibility for the replacement market, and cost increases for higher-efficiency motors. (*Id*.) AHRI stated that these factors make DOE's 3-year compliance period analyzed in the October 2023 NOPR infeasible, as meeting the standards would require substantial investment, resources, and innovation by manufacturers. (*Id*.) Hussmann commented that it incorporated by reference AHRI's comment that there is a cumulative regulatory burden associated with the October 2023 NOPR. (Hussmann, No. 80 at p. 14) Hussmann similarly emphasized that the motors rulemakings could also impact CRE manufacturers. (*Id*.)

Hoshizaki commented that ACIM and CRE regulations have converging compliance dates for new safety regulations, the refrigerant transition, and DOE energy conservation standards. (Hoshizaki, No. 76 at p. 6) Hoshizaki added that industry is still trying to understand the scope of change needed for the transition to UL 60335-2-89, which is required for most commercial refrigeration categories starting in September 2024. (*Id*.) Hoshizaki commented that it is also tracking the development of chemical (*e.g.*, PFAS) regulations. (*Id.* at p. 7)

SCC similarly commented that the cumulative regulatory burden from EPA refrigerant regulations, new safety standards, DOE's ACIM and WICF energy conservation standards rulemakings, and PFAS reporting make it challenging to analyze and comply with these regulations within the required timeframes. (SCC, No. 74 at pp. 1, 4) SCC emphasized that each rulemaking requires significant engineering time, capital costs, testing validation, and independent laboratory certification. (*Id*. at p. 4) SCC commented that 3 years is an insufficient amount of time to comply with the standards proposed in the October 2023 NOPR, given the cumulative regulatory burden from overlapping rulemakings. (*Id.*)

Hussmann highlighted that many State and local building codes prohibit the use of A2Ls and must be updated outside of the normal cycle of building code revisions, which commonly take 2 to 5 years to complete. (Hussmann, No. 80 at p. 2) Hussmann commented only eight States have updated their codes to allow A2L refrigerants in CRE, and more than 20 States and all U.S. territories have not yet passed legislation authorizing the use of A2L refrigerants for CRE. (*Id*.) Hussmann commented that manufacturers currently face uncertainty around the use of A2L but stated that AHRI is dedicating resources to allow A2Ls in CRE in all States and territories to allow A2Ls in building codes by mid-2024. (*Id*.; *see also* AHRI, No. 81 at p. 2) In response to the August 2024 NODA, NAMA requested that DOE consider the regulatory burden associated with changing State and local building codes. NAMA commented that National, State, and local building codes may not be finalized before the proposed compliance date for CRE. (NAMA, No. 112 at pp. 4, 9) If building codes are not updated, NAMA asserted that manufacturers may build two versions of models with either R-290 refrigerants or a blend of low-GWP refrigerants and higher-GWP refrigerants. (*Id.* at p. 4)

In response to the October 2023 NOPR and August 2024 NODA, Hussmann commented that it faces simultaneous UL 60335-2-89, NSF, FDA, EPA, and DOE rulemakings, as well as issues related to A2L supply chain, other supply chain issues, time constraints, resource constraints, retooling costs, investments for R&D for CRE and walk-in refrigerators and freezers, and laboratory and capacity limitations. (Hussmann, No. 80 at p. 2 and Hussmann, No. 108 at p. 1) NAFEM commented that its members face overlapping regulations from Federal, State, local, and industrial authorities: the October 2023 EPA Final Rule will have an impact on energy efficiency, UL 60335-2-89 will have a multi-year impact, equipment must meet NSF sanitation requirements, and all equipment must comply with ASHRAE safety requirements. (NAFEM, No. 83 at p. 16) NAFEM commented that many CRE manufacturers must also accommodate changes in ACIMs during a similar timeframe. (*Id.* at p. 13) NAMA commented the industry has experienced regulatory pressure for 5 years, citing DOE’s March 2014 Final Rule with compliance in 2017, new ENERGY STAR levels, State-level refrigerant regulations, COVID-19, inflation, and labor shortages for skilled workers. (NAMA, No. 85 at pp. 3–4) In response to the October 2023 NOPR and August 2024 NODA, NAMA commented that cumulative regulatory burden should include changes necessary to adhere to local and State building codes. (NAMA, No. 85 at p. 18 and

NAMA, No. 112 at p. 7) NAMA stated California, Oregon, Washington, and other States have changed refrigerant regulations, including retiring HFC refrigerants. (NAMA, No. 85 at p. 17)

With respect to comments regarding the regulatory burden, DOE recognizes that the CRE industry faces overlapping regulations from Federal, State, local, and industrial entities. DOE analyzes and considers the impact on manufacturers of multiple product/equipment-specific Federal regulatory actions. DOE analyzes cumulative regulatory burden pursuant to section 13(g) of the Process Rule. 10 CFR 431.4; 10 CFR 430, subpart C, appendix A, section 13(g). DOE notes that regulations not yet finalized (*e.g.*, DOE energy conservation standards for ACIMs and BVMs) are not considered as cumulative regulatory burden, as the timing, cost, and impacts of unfinalized rules are speculative. However, to aid stakeholders in identifying potential cumulative regulatory burden, DOE does list rulemakings that have proposed rules with tentative compliance dates, compliance levels, and compliance cost estimates. The results of this analysis can be found in section V.B.2.e of this document. As shown in Table V.67 in section V.B.2.e of this document, DOE considers the potential cumulative regulatory burden from other DOE energy conservation standards rulemakings for a range of DOE rulemakings, including WICFs, in this final rule analysis. DOE also considers the cost to comply with the October 2023 EPA Final Rule in its analysis. DOE estimates industry will need to invest \$13.6 million in R&D and \$17.7 million in capital expenditures to transition to low-GWP refrigerants over the next 2 years.

Regarding the comments about EPA's ENERGY STAR levels, DOE notes that participating in ENERGY STAR is voluntary and not considered in DOE's analysis of cumulative regulatory burden. Regarding the comments about updates to State and local building codes allowing A2L refrigerants in CRE, DOE understands that building codes can limit refrigerants available for use in certain end-uses, including CRE, based on their flammability, the charge size of the equipment, and other relevant safety factors. Building codes are established at the subnational level and can differ greatly across jurisdictions. DOE understands that, in some cases, jurisdictions still need to update their building codes for some substitutes to be available for certain uses. Subsection (i)(4)(B) of the AIM Act, codified at 42 U.S.C. 7675, directs EPA, to the extent practicable, to take building codes into account in its consideration of availability of substitutes when establishing refrigerant restrictions. As such, the October 2023 EPA Final Rule considered whether current building codes permit the installation and use of equipment and systems using substitutes, particularly with respect to setting compliance dates for refrigerant restrictions. As discussed in the October 2023 EPA Final Rule, EPA found it reasonable to consider that jurisdictions will prioritize completing the necessary updates with the October 2023 EPA Final Rule compliance dates in mind. 88 FR 73098, 73135–73136. For many subsectors, including remote condensing CRE equipment classes, the October 2023 EPA Final Rule provided additional time to comply with refrigerant restrictions as compared to the December 2022 EPA NOPR to enable jurisdictions to update their building codes or legislation accordingly. *Id*. at 88 FR 73136. DOE notes that the compliance dates detailed in the October 2023 EPA Final Rule for categories relevant to CRE are 2 to 4 years earlier than the compliance date for new and amended CRE energy conservation standards. As such, DOE anticipates that building codes should not impact a manufacturer's ability to transition to A2L refrigerants by the DOE compliance year. See section IV.C.1.a of this document for additional discussion on building codes.

Regarding the ESEM proposed rule published on December 15, 2023, DOE expects that CRE covered by the ESEM rulemaking would not be directly impacted because the motors used in CRE are typically below 0.25 horsepower, and, thus, are outside the scope of the ESEM rulemaking. See 88 FR 87062. Furthermore, as DOE did not identify any CRE manufacturers that also manufacture ESEMs, DOE did not include CRE manufacturers in the ESEM proposed rule in its cumulative regulatory burden analysis. Regarding potential PFAS regulations restricting the use of certain A2L refrigerants, DOE notes that EPA has not yet proposed any regulations concerning the use of PFAS in refrigerants. DOE notes that EPA's "PFAS Strategic Roadmap" sets timelines for specific actions and outlines EPA's commitments to new policies to safeguard public health, protect the environment, and hold polluters accountable.[137]

Regarding State refrigerant regulations, those transition costs are reflected in the refrigerant transition costs estimated in this final rule (see section V.B.2.e of this document). DOE notes that two States have established GWP limits for certain remote-condensing CRE that are lower (*i.e.*, more restrictive) than the October 2023 EPA Final Rule for some CRE categories. Specifically, California and Washington prohibited refrigerants with a GWP of 150 or greater for new retail food refrigeration equipment containing more than 50 lbs refrigerant, which includes certain self-contained and remote-condensing CRE, as of January

[137] U.S. Environmental Protection Agency, "Per- and Polyfluoroalkyl Substances (PFAS)." Available at: *www.epa.gov/pfas* (last accessed October 23, 2024).

1, 2022 in California[138] and as of January 1, 2025 in the State of Washington.[139] Because CRE connected to a remote condensing unit can be connected to multiple types of remote condensing systems with varying refrigerant charge sizes (*e.g*., dedicated condensing unit or compressor rack system), and State regulations align with the most restrictive GWP limit in the October 2023 EPA Final Rule for CRE, DOE does not expect that individual State refrigerant regulations would further contribute to refrigerant transition costs beyond what was assessed for the October 2023 EPA Final Rule for the equipment covered by this final rule. DOE is already basing its engineering analysis on the most restrictive GWP limit (*i.e.*, 150 GWP) to account for the potential variation in remote condensing system refrigerant charge sizes.

In response to the October 2023 NOPR and August 2024 NODA, NAMA commented that DOE should investigate the cumulative burden of the ongoing BVM rulemaking and combine the costs of compliance with multiple regulations into the product conversion costs and GRIM spreadsheets to reflect the costs of responding to and monitoring regulations. (NAMA, No. 85 at pp. 17–18; NAMA, No. 112 at p. 8) NAMA added the GRIM does not show recoupment of investments from multiple product regulations within the six-year lock-in period and recommends DOE consolidate analysis for multiple regulations. (NAMA, No. 112 at p. 8)

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[138] California Air Resource Board, "California Significant New Alternatives Policy (SNAP)." Available at *ww2.arb.ca.gov/our-work/programs/california-significant-new-alternatives-policy-snap/retail-food-refrigeration* (last accessed May 23, 2024).
[139] State of Washington Department of Ecology, WAC 173-443-040. Available at *app.leg.wa.gov/WAC/default.aspx?cite=173-443-040* (last accessed May 23, 2024).

Regarding incorporating the combined product conversion costs from the BVM rulemaking into the CRE GRIM (and vice versa), DOE is concerned that combined results would make it more difficult to discern the direct impact of a new or amended standard on covered manufacturers, particularly for rulemakings where there is only partial overlap of manufacturers, which is the case for BVMs and CRE. The GRIM prepared for this rulemaking is specific to the CRE industry. Inputs to the GRIM such as annual shipments, production costs, conversion costs, cost structure, discount rate, *etc*., reflect the CRE industry. As such, MIA results only encompass industry revenue and annual cash flow associated with shipments of CRE covered by this specific rulemaking. If DOE were to combine the conversion costs from multiple regulations into the CRE GRIM, as requested, it would be appropriate to also include the combined revenues of the relevant regulated products or equipment. For rulemakings with only a partial overlap of manufacturers, conversion costs would be spread over a larger revenue base and result in less severe INPV impacts when evaluated on a percent change basis. For instance, of the 5 BVM manufacturers and of the 103 CRE manufacturers, only 1 manufacturer makes both BVMs and CRE.

In response to the October 2023 NOPR, Zero Zone expressed concern about the third segment of the AIM Act, which regards managing HFC use and reuse. (Zero Zone, No. 75 at p. 1) Zero Zone commented that this proposed regulation has requirements for leak detection and repair that would increase the purchase and operating cost of refrigerating equipment, and the phasedown of HFC refrigerant will increase the cost of equipment for stores. (*Id.*) Zero Zone commented that those cost changes in addition to the costs of design changes to meet the proposed energy conservation standard will reduce overall industry sales volume, which would be detrimental to manufacturers. (*Id.*)

On October 19, 2023, EPA published a proposed rule in the *Federal Register* to address and control certain activities regarding the servicing, repair, disposal, or installation of equipment that involves HFCs or their substitutes. 88 FR 72216. On October 11, 2024, EPA finalized its proposed rule. 89 FR 82682. DOE anticipates that EPA's rule may necessitate additional components or design changes (*e.g.*, automatic leak detection) in certain CRE covered by this rulemaking. Zero Zone's comment did not quantify the increase in cost to CRE within the scope of this final rule. However, DOE expects that any costs associated with complying with EPA's rule would apply to relevant CRE models at all efficiency levels regardless of the energy conservation standard adopted in this final rule. Because the cost impacts from EPA's rule are not efficiency-related costs but rather would be incurred due to EPA requirements that are applicable at all efficiency levels, DOE has not considered the impacts of these changes on MPCs in this final rule. See section IV.C.2 of this document for additional information on DOE's cost analysis.

f. Refrigerant Transition

In response to the October 2023 NOPR, NAFEM commented that the October 2023 NOPR fundamentally ignores the context of other significant changes impacting the CRE industry at this time. (NAFEM, No. 83 at p. 16) NAFEM commented that DOE is not accounting for the significant capital and other investments that were made, and continue to be made, in the shift to new refrigerants under the AIM Act. (*Id*. at p. 15) NAFEM asserted that DOE's analysis does not account for manufacturers trying to recover the costs of these substantial investments made to comply with the October 2023 EPA Final Rule. (*Id*.) NAFEM commented that, contrary to the information in the October 2023 NOPR, the changeover to natural refrigerants is underway but not complete in the CRE industry, mostly because necessary capital improvements are extremely expensive, far more than those listed in the October 2023 NOPR TSD. (*Id*.)

AHRI commented that manufacturers have delayed their refrigerant transition due to COVID-19, component shortages, and long lead times. (AHRI, No. 81 at p. 8) AHRI stated that equipment designs will be impacted by the October 2023 EPA Final rule, which will go into effect in 2025 for self-contained equipment classes and 2026 or 2027 for remote condensing equipment classes. (*Id*.) AHRI commented that DOE did not include any increase in capital costs for the conversion from R-404A to R-290 refrigerant in the baseline assessment. (AHRI, No. 81 at p. 7)

In response to both the October 2023 NOPR and August 2024 NODA, NAMA commented that the CRE industry is burdened by the ongoing transition to low-GWP refrigerants and new safety standards, which require capital improvements to factories, changes to service, and training of factory employees. (NAMA, No. 85 at p. 4; NAMA, No. 112 at p. 5) In particular, NAMA commented that DOE underestimated the capital costs associated with transitioning to low-GWP refrigerants. (*Id.* at pp. 4, 8) NAMA commented also that while the October 2023 NOPR TSD acknowledges the need to change multiple components, the product and capital costs shown are far below what manufacturers must incur to fully implement the use of A3 refrigerants. (NAMA, No. 85 at pp. 7–8)

NAMA stated that the costs of converting to alternative, low-GWP refrigerants has cost millions of dollars for its members, which has been particularly challenging since sales have been down and labor and materials costs have increased. (NAMA, No. 85 at p. 35) NAMA stated its belief that the cost of the refrigerant transition has diverted business resources. (*Id*. at p. 3) NAMA asserted that the cost of the refrigerant transition is higher than the estimated amount in the October 2023 NOPR TSD, especially due to current interest rates, which increase the cost of short-term and long-term borrowing. (*Id.*) NAMA commented that new or amended energy conservation standards from DOE would increase the time to transition CRE to low-GWP refrigerants due to supply chain issues and limited staffing for some manufacturers. (*Id*. at p. 8)

In response to the October 2023 NOPR and August 2024 NODA, Hussmann commented that complying with the October 2023 EPA Final rule necessitates changes to its manufacturing processes, retooling of equipment, and R&D investment. (Hussmann, No. 80 at p. 1; Hussmann No. 108 at p. 1) Hussmann commented that there are supply chain constraints surrounding sourcing components for CRE using A2L refrigerants since components are pending third-party regulatory compliance. (*Id.*) Hussmann stated that because A2L components are new, components must be purchased, designed, installed in models, and undergo performance and safety validation. (*Id.*) Hussmann stated A2L components also require UL certification. (Hussmann, No. 108 at p. 1) Hussmann commented that its costs of transitioning one factory to low-GWP refrigerants included: $700,000 for engineering resources, $500,000 in testing, $600,000 in laboratory equipment, $10,000 in certification costs, $300,000 in manufacturing efforts for self-contained equipment, and $500,000 for manufacturing equipment for self-contained equipment.

(Hussmann, No. 80 at p. 15) In response to the August 2024 NODA, the CA IOUs agreed with DOE's analysis that manufacturer R&D costs will increase due to the revised compliance dates for CRE from the October 2023 EPA final rule. (CA IOUs, No. 113 at p. 2)

In response to the comments from NAFEM, AHRI, NAMA, the CA IOUs and Hussmann, DOE recognizes that redesigning CRE models to comply with EPA's refrigerant regulation and DOE's new and amended energy conservation standards requires significant engineering resources and capital investment. DOE analyzed the potential impacts of the December 2022 EPA NOPR in its October 2023 NOPR. Based on the December 2022 EPA NOPR, DOE modeled the CRE industry transitioning to low-GWP refrigerants prior to EPA's proposed January 1, 2025 compliance date. However, EPA has since finalized refrigerant restrictions affecting CRE (*i.e.*, the October 2023 EPA Final rule). The October 2023 EPA Final rule prohibits the manufacture or import of self-contained CRE with HFCs and HFC blends with GWPs of 150 or greater starting January 1, 2025 (for the CRE covered by this rulemaking). For other CRE covered by this rulemaking, the October 2023 EPA Final rule adopted later compliance dates of January 1, 2026 or January 1, 2027 based on equipment type.

DOE notes that it accounts for industry refrigerant transition expenses in its GRIM in the no-new-standards case and standards cases because investments required to transition to low-GWP refrigerants in response to the October 2023 EPA Final Rule likely necessitates a level of investment beyond typical annual R&D and capital expenditures. DOE incorporates these expenses into its GRIM as part of the analytical baseline to better reflect the state of industry finances and annual cash flow. For the October 2023 NOPR, DOE relied on a range of sources, including feedback gathered during confidential manufacturer interviews and investment estimates submitted by NAMA and AHRI in response to the June 2022 Preliminary Analysis. In response to written comments to the October 2023 NOPR, DOE revised its refrigerant transition R&D estimates (see Hussmann, No. 80 at p. 15). DOE did not revise its estimates of refrigerant transition capital expenditures as stakeholder feedback aligned with the methodology used in the October 2023 NOPR. Based on these sources, DOE modeled the transition to low-GWP refrigerants would require industry to invest approximately $13.6 million in R&D and $17.7 million in capital expenditures (*e.g.*, investments in new charging equipment, leak detection systems, *etc.*) from 2024 (the final rule reference year) and 2027 (the latest EPA compliance date for CRE covered by this rulemaking). However, DOE acknowledges that many manufacturers have made significant investments to transition to low-GWP refrigerants prior to 2024, which would not reflected in the GRIM as those costs were incurred outside of the analysis period for this rulemaking (2024–2058). See section V.B.2.e of this document for additional discussion of how DOE accounts for cumulative regulatory burden in its analysis. DOE incorporated the potential redesign costs (*i.e.*, product conversion costs) and capital investment (*i.e.*, capital conversion costs) needed to meet various standard levels in its MIA. See section IV.J.2.c of this document for additional discussion of conversion costs.

K. Emissions Analysis

The emissions analysis consists of two components. The first component estimates the effect of potential energy conservation standards on power sector and site (where applicable) combustion emissions of CO_2, NO_X, SO_2, and Hg. The second component estimates the impacts of potential standards on emissions of two additional GHG, CH_4 and N_2O, as well as the reductions in emissions of other gases due to "upstream" activities in the fuel production chain. These upstream activities comprise extraction, processing, and transporting fuels to the site of combustion.

The analysis of electric power sector emissions of CO_2, NO_X, SO_2, and Hg uses emissions intended to represent the marginal impacts of the change in electricity consumption associated with amended or new standards. The methodology is based on results published for the *AEO*, including a set of side cases that implement a variety of efficiency-related policies. The methodology is described in appendix 13A in the final rule TSD. The analysis presented in this document uses projections from *AEO2023*. Power sector emissions of CH_4 and N_2O from fuel combustion are estimated using Emission Factors for Greenhouse Gas Inventories published by EPA.[140]

FFC upstream emissions, which include emissions from fuel combustion during extraction, processing, and transportation of fuels, and "fugitive" emissions (direct leakage to the atmosphere) of CH_4 and CO_2, are estimated based on the methodology described in chapter 15 of the final rule TSD.

The emissions intensity factors are expressed in terms of physical units per MWh or MMBtu of site energy savings. For power sector emissions, specific emissions intensity

[140] Available at *www.epa.gov/sites/production/files/2021-04/documents/emission-factors_apr2021.pdf* (last accessed July 22, 2024).

factors are calculated by sector and end use. Total emissions reductions are estimated using the energy savings calculated in the NIA.

1. Air Quality Regulations Incorporated in DOE's Analysis

DOE's no-new-standards case for the electric power sector reflects the *AEO*, which incorporates the projected impacts of existing air quality regulations on emissions. *AEO2023* reflects, to the extent possible, laws and regulations adopted through mid-November 2022, including the emissions control programs discussed in the following paragraphs the emissions control programs discussed in the following paragraphs, and the Inflation Reduction Act.[141]

SO_2 emissions from affected electric generating units ("EGUs") are subject to nationwide and regional emissions cap-and-trade programs. Title IV of the Clean Air Act sets an annual emissions cap on SO_2 for affected EGUs in the 48 contiguous States and the District of Columbia ("D.C."). (42 U.S.C. 7651 *et seq.*) SO_2 emissions from numerous States in the eastern half of the United States are also limited under the Cross-State Air Pollution Rule ("CSAPR"). 76 FR 48208 (Aug. 8, 2011). CSAPR requires these States to reduce certain emissions, including annual SO_2 emissions, and went into effect as of January 1, 2015.[142] The *AEO* incorporates implementation of CSAPR, including the update to the

[141] For further information, see the "Assumptions to *AEO2023*" report that sets forth the major assumptions used to generate the projections in the Annual Energy Outlook. Available at *www.eia.gov/outlooks/aeo/assumptions/* (last accessed July 20, 2024).
[142] CSAPR requires States to address annual emissions of SO_2 and NO_X, precursors to the formation of fine particulate matter ("$PM_{2.5}$") pollution, in order to address the interstate transport of pollution with respect to the 1997 and 2006 $PM_{2.5}$ National Ambient Air Quality Standards ("NAAQS"). CSAPR also requires certain States to address the ozone season (May–September) emissions of NO_X, a precursor to the formation of ozone pollution, in order to address the interstate transport of ozone pollution with respect to the 1997 ozone NAAQS.

CSAPR ozone season program emission budgets and target dates issued in 2016. 81 FR 74504 (Oct. 26, 2016). Compliance with CSAPR is flexible among EGUs and is enforced through the use of tradable emissions allowances. Under existing EPA regulations, for States subject to SO_2 emissions limits under CSAPR, any excess SO_2 emissions allowances resulting from the lower electricity demand caused by the adoption of an efficiency standard could be used to permit offsetting increases in SO_2 emissions by another regulated EGU.

However, beginning in 2016, SO_2 emissions began to fall as a result of the Mercury and Air Toxics Standards ("MATS") for power plants.[143] 77 FR 9304 (Feb. 16, 2012). The final rule establishes power plant emission standards for mercury, acid gases, and non-mercury metallic toxic pollutants. Because of the emissions reductions under the MATS, it is unlikely that excess SO_2 emissions allowances resulting from the lower electricity demand would be needed or used to permit offsetting increases in SO_2 emissions by another regulated EGU. Therefore, energy conservation standards that decrease electricity generation will generally reduce SO_2 emissions. DOE estimated SO_2 emissions reduction using emissions factors based on *AEO2023*.

CSAPR also established limits on NO_X emissions for numerous States in the eastern half of the United States. Energy conservation standards would have little effect on NO_X emissions in those States covered by CSAPR emissions limits if excess NO_X emissions

76 FR 48208 (Aug. 8, 2011). EPA subsequently issued a supplemental rule that included an additional five States in the CSAPR ozone season program, 76 FR 80760 (Dec. 27, 2011) (Supplemental Rule), and EPA issued the CSAPR Update for the 2008 ozone NAAQS. 81 FR 74504 (Oct. 26, 2016).

[143] In order to continue operating, coal power plants must have either flue gas desulfurization or dry sorbent injection systems installed. Both technologies, which are used to reduce acid gas emissions, also reduce SO_2 emissions.

allowances resulting from the lower electricity demand could be used to permit offsetting increases in NO_X emissions from other EGUs. In such cases, NO_X emissions would remain near the limit even if electricity generation goes down. Depending on the configuration of the power sector in the different regions and the need for allowances, however, NO_X emissions might not remain at the limit in the case of lower electricity demand. That would mean that standards might reduce NOx emissions in covered States. Despite this possibility, DOE has chosen to be conservative in its analysis and has maintained the assumption that standards will not reduce NO_X emissions in States covered by CSAPR. Standards would be expected to reduce NO_X emissions in the States not covered by CSAPR. DOE used *AEO2023* data to derive NO_X emissions factors for the group of States not covered by CSAPR.

The MATS limit mercury emissions from power plants, but they do not include emissions caps and, as such, DOE's energy conservation standards would be expected to slightly reduce Hg emissions. DOE estimated mercury emissions reduction using emissions factors based on *AEO2023*, which incorporates the MATS.

L. Monetizing Emissions Impacts

As part of the development of this final rule, for the purpose of complying with the requirements of Executive Order 12866, DOE considered the estimated monetary benefits from the reduced emissions of CO_2, CH_4, N_2O, NO_X, and SO_2 that are expected to result from each of the TSLs considered. In order to make this calculation analogous to the calculation of the NPV of consumer benefit, DOE considered the reduced emissions expected to result over the lifetime of equipment shipped during the projection period for each TSL. This section summarizes the basis for the values used for monetizing the emissions benefits and presents the values considered in this final rule.

1. Monetization of Greenhouse Gas Emissions

To monetize the climate benefits of reducing GHG emissions, the October 2023 NOPR used the interim social cost of greenhouse gases ("SC-GHG") estimates presented in the Technical Support Document: Social Cost of Carbon, Methane, and Nitrous Oxide Interim Estimates Under Executive Order 13990 published in February 2021 by the Interagency Working Group on the SC-GHG ("IWG") ("2021 Interim SC-GHG estimates"). As a member of the IWG involved in the development of the February 2021 SC-GHG TSD, DOE agreed that the 2021 interim SC-GHG estimates represented the most appropriate estimate of the SC-GHG until revised estimates were developed reflecting the latest, peer-reviewed science. See 87 FR 78382, (Dec. 21, 2022) 78406-78408 for discussion of the development and details of the 2021 interim SC-GHG estimates. The IWG has continued working on updating the interim estimates but has not published final estimates.

Accordingly, in the regulatory analysis of its December 2023 Final Rule, "Standards of Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review," the Environmental Protection Agency ("EPA") estimated climate benefits using a new, updated set of SC-GHG estimates ("2023 SC-GHG estimates"). EPA documented the methodology underlying the new estimates in the RIA for the December 2023 Final Rule and in greater detail in a technical report entitled "Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances" ("Final Report") that was presented as

Supplementary Material to the RIA. The 2023 SC-GHG estimates address the recommendations of the National Academies of Science, Engineering, and Medicine (National Academies) by incorporating recent research and responses to public comments. The public comments include those on an earlier sensitivity analysis contained in EPA's December 2022 proposal in the oil and natural gas sector standards of performance rulemaking along with comments on a 2023 external peer review of the accompanying technical report.

On December 22, 2023, the IWG issued a memorandum directing that when agencies "consider applying the SC-GHG in various contexts . . . agencies should use their professional judgment to determine which estimates of the SC-GHG reflect the best available evidence, are most appropriate for particular analytical contexts, and best facilitate sound decision-making" consistent with OMB Circular A-4 and applicable law.

DOE has been extensively involved in the IWG process and related work on the SC-GHGs for over a decade. This involvement includes DOE's role as the federal technical monitor for the seminal 2017 report on the SC-GHG issued by the National Academies, which provided extensive recommendations on how to strengthen and update the SC-GHG estimates. DOE has also participated in the IWG's work since 2021. DOE technical experts involved in this work reviewed the 2023 SC-GHG methodology and report in light of the National Academies' recommendations and DOE's understanding of the state of the science.

Based on this review, in the August 2024 NODA, DOE proposed for public comment its preliminary determination that the updated 2023 SC-GHG estimates, including the approach to discounting, represent a significant improvement in estimating the SC-GHG through incorporating the most recent advancements in the scientific literature and by addressing recommendations on prior methodologies. That NODA presented climate benefits using both the 2023 SC-GHG estimates and the 2021 interim SC-GHG estimates. In this final rule, DOE has not made a final decision regarding that preliminary assessment or adoption of the updated 2023 SC-GHG estimates, as such a decision is not necessary for purposes of this rule. In this final rule, DOE is presenting estimates using both the updated 2023 SC-GHG values and the 2021 interim SC-GHG estimates, as DOE believes it is appropriate to give the public more complete information regarding the benefits of this rule. DOE notes, however, that the adopted standards would be economically justified using either set of SC-GHG values, and even without inclusion of the estimated monetized benefits of reduced GHG emissions. In future rulemakings, DOE will continue to evaluate the applicability in context and use our professional judgment to apply the SC-GHG estimates that are most appropriate to use at that time.

The 2023 EPA technical report presents SC-GHG values for emissions years through 2080; therefore, DOE did not monetize the climate benefits of GHG emissions reductions occurring after 2080 when using the 2023 estimates for the SC-GHG. DOE expects additional climate impacts to accrue from GHG emissions changes post 2080, but due to a lack of readily available SC-GHG estimates for emissions years beyond 2080 and the relatively small emission effects expected from those years, DOE has not monetized these additional impacts in this analysis. Similarly, the 2021 interim SC-GHG estimates include values through 2070. DOE expects additional climate benefits to accrue for products still operating after 2070, but a lack of available SC-GHG estimates published by the IWG for emissions years beyond 2070 prevents DOE from monetizing these potential benefits in this analysis.

The overall climate benefits are generally greater when using the higher, updated 2023 SC-GHG estimates, compared to the climate benefits using the older 2021 interim SC-GHG estimates, which were used in the July 2023 NOPR. The net benefits of the rule are positive, however, under either SC-GHG calculation methodology; in fact, the net benefits of the rule are positive without including any monetized climate benefits at all. The adopted standards would be economically justified even without inclusion of the estimated monetized benefits of reduced GHG emissions using either methodology, therefore the conclusions of the analysis (as presented in section V.C of this document) are not dependent on which set of estimates of the SC-GHG are used in the analysis or on the use of the SC-GHG at all. The adopted standard level would remain the same under either SC-GHG calculation methodology (or without using the SC-GHG at all).

DOE received several comments regarding its preliminary determination on the use of the 2023 SC-GHG methodologies in the August 2024 NODA. As noted above, DOE is not making a final determination regarding which of the two sets of SC-GHG is most appropriate to apply here. Accordingly, DOE is not addressing in this rule comments regarding such a final determination. Because DOE is presenting results using both sets of estimates, however, to the extent that commenters raised concerns about any reference to the 2023 SC-GHG methodologies, DOE is responding to that limited set of comments here.

Commenter Pacific Gas & Electric (PG&E) et al. expressed support for the 2023 update on SC-GHG methodologies and for use of these estimates in DOE policy analysis. (PG&E et al., No. 113 at p. 2). PG&E et al. stated that the use of the 2023 SC-GHG methodologies is consistent with the Office of Management and Budget (OMB) recommendations to use the best and most recent available estimates for calculating the social cost of carbon. (PG&E et al., No. 113 at p. 2).

Commenters Hussman Corporation, American Lighting Association (ALA) et al., Competitive Enterprise Institute (CEI), and National Association of Home Builders (NAHB) expressed general opposition to the use of a metric that monetizes carbon emissions, and they criticized especially the use of the 2023 SC-GHG methodologies. (Hussman Corporation, No. 108 at p. 3; ALA et al., No. 109 at p. 2; NAHB, No. 103 at p. 4). NAHB stated that, "the monetized value of [SC-GHG] is highly esoteric, is not tied to tangible outcomes, and will not lead to real change intended in the EERE mission and priorities." NAHB further requested that DOE limits its use of SC-GHG in the future and not use it as a metric for setting minimum efficiency criteria. (NAHB, No. 103 at p. 4) Commenter (CEI) stated that SC-GHG is not a valid approach to monetizing impacts from emissions.

DOE acknowledges the comments expressing general opposition to the 2023 SC-GHG methodologies and their use in these policy analyses. In this final rule, DOE is presenting SC-GHG results using both the interim 2021 SC-GHG estimates and the updated 2023 SC-GHG estimates. DOE notes again that it would promulgate the same standards in these final rules even in the absence of the benefits of the GHG reductions achieved by the rule.

Some commenters (NAHB, ALA, et al., and the U.S. Chamber of Commerce et al.) argued that there is a significant lack of clarity as to how the methodology was applied and how the results were produced. Overall, commenters requested more transparency within the modeling process. Commenter (ALA et al.) affirmed that it may be appropriate for DOE to examine the SC-GHG and monetization of other emissions reductions benefits as informational if the underlying analysis is transparent and vigorous and reviewed by properly qualified peer reviewers. However, ALA maintained that the benefits calculated with the SC-GHG should not be used to justify a rule given the uncertain and ever-evolving nature of those estimates. (ALA et al., No. 109 at pp. 3–4)

Commenter (U.S. Chamber of Commerce et al.) stated that the December 22, 2023, IWG memo "lacked any discussion of the methodologies, assumptions, or models used by the EPA in revising the estimates." U.S. Chamber of Commerce further criticized that while EPA provided some technical documentation in support of its new SG-GHG estimates, the overall lack of transparency within the decision-making process undermines the credibility of the estimates. The group also stated that the IWG memo does not direct agencies which values to use, allowing agencies to use any estimate, which would lead to inconsistent use of the SC-GHG estimates across the government. (U.S. Chamber of Commerce et al., No. 115 at p. 3)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address the substance of these comments insofar as they assess the relative merits of the two sets of estimates. Insofar as these comments object to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that EPA made documentation available in support of the draft updated 2023 SC-GHG estimates used in the sensitivity analysis in EPA's December 2022 Regulatory Impact Analysis, as well as in support of the final updated SC-GHG estimates used in EPA's Dec. 2023 Final Rule. This includes the final technical report explaining the methodology underlying the new set of SC-GHG estimates, files to support independent replication of the SC-GHG estimates, a workbook to support members of the public in applying the SC-GHG estimates in their own analyses, public comments relating to SC-GHG estimates as part of the December 2022 RIA, EPA responses to those public comments, and extensive documentation on the peer review process, including information about the public input opportunities in the peer review panel selection process, the selected peer reviewers, a recording of the peer review meeting, the peer reviewers' report, and EPA's responses to the peer reviewers' report. EPA additionally provided copies of all studies and reports cited in the analysis in the public docket. (EPA RTC A-7-4).

Regarding commenter's concerns regarding IWG's lack of discussion of the 2023 SC-GHG methodologies, insofar as this comment objects to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that the methodologies were not introduced in the IWG memo, but rather in an EPA proposed and final rule and a Final Report. The IWG's lack of discussion does not appear to be relevant.

With respect to the commenter's concern about the potential for different agencies to use different and therefore inconsistent estimates of the SC-GHG, this comment is not directly relevant because DOE is presenting both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates for this rule.

Several commenters (CEI, AHRI, and U.S. Chamber of Commerce et al.) questioned the accuracy of the estimates produced by the 2023 SC-GHG methodologies and called attention to uncertainties in the calculation process. Commenters argue that due to what they view as substantial inaccuracies and uncertainties in the methodologies, they should not be used to justify new and more stringent energy conservation standards. Commenter (CEI) criticizes the 2023 SC-GHG methodologies as "too speculative, too prone to user manipulation, and too reliant on dubious assumptions to either justify regulatory decisions or estimate their net benefits to the public." (CEI1, No. 100 at p. 2; CEI2, No. 102 at p. 10)

Commenter (AHRI) stated that the methodology fails to acknowledge uncertainties and extrapolations regarding the climate modeling and interaction of the four modules. Additionally, AHRI criticized the quantification of the benefits claimed by DOE as "speculative and tangential at best." (AHRI, No. 104 at p. 2)

Commenter (U.S. Chamber of Commerce et al.) identified the scientific underpinnings of the methodologies as a key area of concern. The U.S. Chamber of Commerce claimed that the SC-GHG values are "inherently uncertain because they depend on complex modeling of future economic and environmental impacts — and not just near-term forecasts, but forecasts that project hundreds of years into the future." (U.S. Chamber of Commerce et al., No. 115 at p. 4)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address comments on the uncertainty in the 2023 SC-GHG estimates insofar as they assess the relative merits of the two sets of estimates. Insofar as these comments object to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that some measure of uncertainty is inherent in all complex cost estimates that quantify physical impacts and translate them into dollar values. Moreover, DOE notes that EPA discussed the uncertainty in various aspects of the 2023 SC-GHG estimates, including how it is directly accounted for in each of the modules, in the Final SC-GHG Report, and pointed to discussions of uncertainty in the supporting academic literature. (See, e.g., EPA Report at p. 77; EPA RTC A-1-7). EPA discussed factors not accounted for in the SC-GHG, such as those represented in Table 3.2.1, explicitly acknowledged that there are limits on which damages and impacts the analysis can capture due to data and modeling limitations, and analyzed the omitted damages and modeling limitations, including the net directional changes of the omitted impacts.

Commenter (CEI) criticized the EPA report's lack of "table, chart, or paragraph explaining which factors contribute what percentage of the more than threefold increase in social cost—despite the more than two-thirds reduction in emission baselines." CEI noted that the reduced discount rate is one factor, but not the entire explanation for the increase in SC-GHG values. (CEI2, No. 102 at p. 8)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address the substance of this comment insofar as it calls for a comparison of the relative merits between the two sets of estimates. For informational purposes, DOE notes that EPA stated in the Final Report that the increases in the 2023 SC-GHG estimates are due to the combined effect of multiple methodological updates, and because some of these updates are integrated, a complete decomposition of the incremental contribution of each change is difficult for all three damage functions used in the damage module. (EPA Report at p. 102; EPA RTC A-5-25).

Multiple commenters (National Automatic Merchandising Association (NAMA) and U.S. Chamber of Commerce et al.) raised concerns about whether the new methodologies were sufficiently peer-reviewed by independent experts before DOE utilized them in its analyses. Commenter (NAMA) argued that the updated SC-GHG methodologies deserve an "open discussion" with increased transparency before they are used in regulatory action. NAMA specifically claimed that "the updated IWG report" that the DOE cites in its analyses was never fully peer-reviewed and was not part of an open process. (NAMA, No. 112 at p. 4) Commenter (U.S. Chamber of Commerce et al.) similarly criticized the IWG's lack of transparency and stated that it undermined the credibility of the updated methodologies and raised questions as to whether the estimates were subject to appropriate scrutiny and review. (U.S. Chamber of Commerce et al., No. 115 at pp. 2–3)

Insofar as commenters were referring to the EPA report—and further insofar as this comment objects to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes—DOE notes that these commenters referred to the SC-GHG methodologies "in the IWG report," but DOE is not aware of any report by the IWG concerning the 2023 SC-GHG estimates. There is a December 2023 IWG memo referencing developments in the scientific literature, as well as a February 2021 IWG Technical Support Document that provided Interim SC-GHG estimates, but the December 2023 memo does not introduce any new methodologies. The 2023 SC-GHG estimates were not introduced in the IWG memo but rather in an EPA rule and Final Report.

EPA stated that the 2023 SC-GHG methodologies were subjected to independent peer review in line with EPA's Peer Review Handbook 4th Edition, 2015 and described the process. (EPA RTC A-7-10).

Several commenters (CEI, NAHB, AHRI, U.S. Chamber of Commerce et al., and American Enterprise Institute (AEI)) raised concerns with the discount rates employed in the 2023 SC-GHG methodologies and the substantial consequences of utilizing such rates. Commenters (CEI, NAHB, and AEI) criticized the disproportionate impact that the choice of a lower discount rate had on the end SC-GHG estimates. Commenter (AEI) specifically denounced the “artificially low” rates and maintained that the rates are a result of prioritizing only climate effects and not wealth aggregation, which would more realistically reflect the objectives of each generation. (CEI2, No. 102 at p. 9; NAHB, No. 103 at p. 4; AEI at pp. 8–9) Commenters (AHRI and U.S. Chamber of Commerce et al.) further criticized the rate choices in the methodologies as inconsistent throughout the cost-benefit analysis. Commenters also questioned why such rates were chosen for each context, especially with such significant impact. (AHRI, No. 104 at p. 4; U.S. Chamber of Commerce et al., No. 115 at p. 4)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address comments on the discounting approach used in the 2023 SC-GHG estimates insofar as they assess the relative merits of the two sets of estimates. Insofar as these comments object to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that EPA stated that the introduction of a Ramsey approach rather than a constant interest rate ensures internal consistency within the modeling between the socio-economic scenarios and the discount rate and allows for a more complete accounting of uncertainty. (EPA Report at pp. 63–64; EPA RTC A-5-13). EPA further stated that it selected the rates based on multiple lines of evidence: historical real rates of returns, empirical studies of equilibrium real interest rates, future projections of real interest rates, and surveys of economists and technical experts. (EPA Report at p. 2; EPA RTC A-5-24).

Commenter (CEI2) offered support for the updates to the emissions baseline utilized in the 2023 SC-GHG methodologies. Commenter noted that the new baseline of reduced carbon emissions is more realistic for climate modeling and the SC-GHG metric (CEI2, No. 102 at p. 3)

Multiple commenters (CEI and AEI) stated that the 2023 SC-GHG methodologies improperly continue to rely on Representative Concentration Pathway 8.5 (RCP 8.5) for climate models, despite EPA's switch to more realistic emissions baselines elsewhere in the analysis. Commenter (CEI) specifically stated that the 2023 SC-GHG updates rely on three damage functions based on RCP 8.5 and thus assume substantially greater warming and damage despite otherwise utilizing a lower emissions baseline. (CEI2, No. 102 at p. 9) Commenter (CEI) also noted concerns with the use of SSP3 and SSP5 as "wildly implausible". Commenter (AEI) similarly opposed the continued use of RCP 8.5 for damage functions and climate models and further criticized the inaccuracy of RCP 8.5 in general. Commenter stated that calculations relying on RCP 8.5 are so extreme, they are realistically impossible. (AEI, No. 97 at p. 4)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address the substance of these comments on the emissions baseline insofar as they assess the relative merits of the two sets of estimates. Insofar as these comments object to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that EPA's Final Report states that the updated 2023 SC-GHG estimates use a new methodology (not RCPs or SSPs (Shared Socio-economic Pathways)), to project future emissions scenarios. Per EPA, the new methodology is an internally consistent set of probabilistic projections of population, GDP, and GHG emissions to 2300, developed by expert elicitation (Rennert et al., "The social cost of carbon: Advances in long-term probabilistic projections of population, GDP, emissions, and discount rates," 2022).

Commenters (Gas Analytics and Advocacy Services (GAAS) and AEI) stated that the 2023 SC-GHG methodologies fail to incorporate the environmental benefits of carbon emissions into the analyses. Commenters include planetary greening, increased agricultural productivity, increased water use efficiency, and reduced mortality from cold as potential benefits from increased GHG emissions. (GAAS, No. 96 at p. 6; AEI, No. 97 at pp. 7–8)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address this comment insofar as it assesses the relative merits of the two sets of estimates. Insofar as this comment objects to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, DOE notes that the Final Report states that carbon fertilization and changes to both heat and cold mortality are represented in the updated 2023 SC-GHG estimates (see EPA Report, Table 3.2.1 at p. 87). EPA acknowledged that the analysis is not able to capture all impacts of GHG emissions (both positive and negative) due to data and modeling limitations.

Commenter (CEI) criticized the 2023 SC-GHG methodologies' integration of the mortality effects of climate change through metrics such as "Value of Statistical Life" (VSL). Commenter specifically took issue with the fact that VSL does not account for intergenerational externalities and instead focused on individuals as opposed to society as a whole. As a result, Commenter stated that the use of the metric encourages consumption at the expense of productive investment. (CEI1, No. 100 at pp. 2–3)

Because DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, we do not address this comment insofar as it assesses the relative merits of the two sets of estimates. Insofar as this comment objects to DOE even referring to the 2023 SC-

GHG estimates and using them for informational purposes, we note that in its cost-benefit guidance for federal agencies, OMB endorses VSL as an approach to monetizing reductions in fatality risks, notes that for decades federal agencies have consistently used VSL estimates, and cites EPA's VSL guidelines as an example. (OMB, Circular No. A-4, 49-50 (Nov. 9, 2023)). EPA's VSL methodology was also peer reviewed by its Science Advisory Board (EPA Report at pp. 1633–167; EPA RTC A-4-11). As an additional point of reference, DOE's methodology for determining the monetized benefits of reductions in SOx and SO2 emissions, as described in the TSDs accompanying the rule, are also based upon the EPA's benefit-per-ton (BPT) analysis of emissions reduction benefits that in turn are based upon the VSL approach. DOE also notes that the commenter incorrectly asserted that the incorporation of mortality effects is new to the 2023 SC-GHG estimates. Previous estimates of SC-GHG also reflect willingness to pay to reduce mortality risk and in some cases also use VSL specifically.

A commenter (CEI1) stated that the characterization of SC-GHG estimates as monetized is misleading. Commenter asserted that calculations are measured in "welfare" rather than money and cannot be compared with other dollar values. Commenter also stated that SC-GHG estimates are ordinal rather than cardinal and therefore don't express degree of relative benefit. (CEI1, No. 100 at p. 4)

This comment goes to any SC-GHG estimates, not the 2023 SC-GHG estimates specifically. SC-GHG is a measure of aggregate willingness to pay, rather than utility as the commenter suggests. It does not measure how much utility changes as a result of additional emissions. Instead, SC-GHG measures how much income society could forgo today with a given emission reduction and be as well off as it would have been without such a reduction (EPA Report at p. 5, 94, and 163). This is a standard economic method for valuing nonmarket goods, and the calculations yield a dollar value, correctly labeled in dollars, for the benefits of emission reductions. This is a cardinal measure that can be compared with any other dollar value as part of a cost benefit analysis.

Commenter (CEI1) stated that because SC-GHG estimates were developed using a normative approach, specifically optimizing utility using a social welfare function, with a social planner framework, to determine how intergenerational impacts should be weighted, they are inconsistent with economic efficiency. (CEI1, No. 100 at p. 4)

This comment goes to all SC-GHG estimates, not the 2023 SC-GHG estimates. specifically.. DOE acknowledges that there are inherent uncertainties in capturing trade-offs over extended time periods. Both the interim 2021 SC-GHG estimates and the 2023 SC-GHG estimates are based on empirical evidence as described by the peer-reviewed literature (EPA Report at pp. 19–76), and both rely on a descriptive, rather than normative, approach to inform discount rate choices, which the IWG has found to be the most defensible and transparent (IWG, February 2010 Technical Support Document at p. 19; see EPA Report at pp. 62–64 for further discussion). This allows for discount rates to be chosen that are consistent with empirical evidence.

Commenter (AEI) stated that the Biden administration mischaracterizes the GDP effects of rising GHG concentrations in its 2023 SC-GHG methodologies. Commenter instead maintains that GDP data supports the contention that the prospective financial risks of anthropogenic climate change, at least in the aggregate, are much smaller than the SC-GHG estimates suggest. (AEI, No. 97 at p. 9)

As DOE is presenting climate benefits using both the interim 2021 SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards, DOE does not address this comment insofar as it assesses the relative merits of the two sets of estimates. Insofar as this comment objects to DOE even referring to the 2023 SC-GHG estimates and using them for informational purposes, we note that Figure 2.1.2 in the EPA Final Report shows the projections of per capita GDP growth rate over the period 2020 – 2300, with the RFF-SP projections used in the 2023 SC-GHG estimates remaining at rates under 2 percent and the other scenarios ranging to just over 4 percent (EPA Report at p. 30). DOE further notes that GDP projections are not equivalent to total social cost, as they only measure economic output, while social cost aims to measure well-being, including many non-market factors that are impacted by climate change, such as human health. Commenters (AHRI and ALA et al.) cited the requirement in EPCA section 6295(o)(2)(B) for DOE to consider seven separate factors when evaluating whether a new or amended energy conservation standard is economically justified. Commenters stated that DOE's use of the SC-GHG metric dominated the economic justification analysis of the rule, effectively disregarding the other factors in violation of the statute. Commenter (AHRI) stated that the statutory text provides no indication one factor should be given more weight than others. (AHRI, No. 104 at p. 3) Commenter (ALA et al.) objected to DOE's "reliance" on the economic benefits produced by the 2023 SC-GHG methodologies and reiterated that DOE is required to balance EPCA's seven factors together. (ALA et al., No. 109 at pp. 3–4)

These comments largely go to use of any estimate of SC-GHG in this rulemaking. DOE has long included SC-GHG estimates in its economic justification analyses pursuant to section 6295(o)(2)(B)(i) of EPCA. In deciding if an energy conservation standard is economically justified under EPCA, DOE must consider, to the greatest extent practicable, seven statutory factors, including the need for national energy and water conservation. (42 U.S.C. 6295(o)(2)(B)(i)(I)-(VII)). Under that requirement, DOE estimates environmental and public health benefits associated with the more efficient use of energy. The adopted standards are likely to result in environmental benefits in the form of reduced emissions of air pollutants and greenhouse gases associated with energy production and use. DOE conducts an emissions analysis to estimate how potential standards may affect these emissions and estimates the economic value of emissions reductions. DOE disagrees with commenters' assertion that the agency failed to adequately balance the other six factors in its analysis or that the SC-GHG metric (under either estimate) overpowers the other factors. DOE found that the standards would be economically justified – i.e., meet the section 6295(o)(2)(B)(i) criteria – without taking any of the benefits of GHG emissions reductions (as calculated by either the 2023 SC-GHG estimates or the interim 2021 SC-GHG estimates) into account. DOE reiterates that the SC-GHG values are not determinative in this rulemaking as DOE would promulgate the same standards even in the absence of the estimated climate benefits (using either the 2021 or the 2023 calculation methodology).

Multiple commenters (NAHB, AHRI, and AEI) highlighted the global nature of the impacts and benefits represented in the 2023 SC-GHG estimates and deemed this inappropriate in the context of U.S. domestic policy and rulemaking.

Commenters (NAHB and AEI) criticized conflation of global and domestic metrics in the 2023 SC-GHG methodologies and stated that the inclusion of global metrics will incorrectly incentivize international and domestic climate measures. Commenters further predicted that the inclusion of global metrics will impose unnecessary costs on U.S. consumers and the domestic economy. Commenter (NAHB) asserted that this is a disproportional distribution of costs and benefits and is effectively a tax through regulation. (NAHB, No. 103 at p. 3; AEI, No. 97 at p. 7). Commenter (AHRI) stated that EPCA has a domestic focus and argued that to reframe EPCA into a globally oriented statute would ignore its legislative history and contradict its focus on benefits accruing solely within the United States. (AHRI, No. 104 at p. 2)

These comments go to both the interim 2021 SC-GHG estimates and the 2023 SC-GHG estimates. Both sets of SC-GHG estimates reflect the global cost of climate change impacts given the distinctive global nature of the climate change problem. Numerous impacts of global climate change occur outside of U.S. territories that directly affect U.S. residents, U.S. companies, the U.S. economy, and U.S. national security and geopolitical interests. Also, if each country were to design emissions policies accounting for only the burdens inflicted on their own citizens and residents, none of the "foreign" impacts of emissions would be accounted for by any country and so all countries would under-regulate GHG emissions. This would, in turn, cause significant harm to U.S. citizens and residents. .

DOE disagrees with commenter's contention that EPCA restricts DOE's estimates of the benefits of avoiding GHG emissions only to direct domestic benefits. The economic justification analysis under EPCA contains no such limiting language regarding consideration of global or domestic emissions benefits and burdens. (42 U.S.C. 6295(o)(2)(B)(i)(I)-(VII)). Also see Zero Zone, Inc. v. United States DOE, 832 F.3d 654, 678-79 (7th Cir. 2016) in which the Seventh Circuit Court of Appeals rejected a petitioner's challenge to DOE's use of a global social cost of carbon in setting an efficiency standard under EPCA and upheld DOE's consideration of global impacts in its climate analysis. In any event, comments on DOE's consideration of transboundary climate impacts are not ultimately relevant because, as stated above, the SC-GHG values are not determinative in this rulemaking and DOE would promulgate the same standards even in the absence of any climate benefits (domestic or global).

Commenter (AHRI) argued that DOE's use of the SC-GHG violates the Major Questions Doctrine. The commenter asserts that as the impact for the SC-GHG resulting from the proposed commercial refrigeration equipment rule was estimated at $671.4 million, the rule asserts a claim of authority concerning vast economic significance that Congress has not provided to it. AHRI maintained that EPCA did not provide DOE with clear authority to regulate emissions when evaluating new or amended standards and thus the inclusion of such analysis in the rulemaking violates the Major Questions Doctrine. (AHRI, No. 104 at p. 4)

Commenter (GAAS) similarly incorporated a "Science Matters" article into its comment citing a 2022 court case challenging the federal government's use of SC-GHG as a violation of the Major Questions Doctrine. (GAAS, No. 96 at p. 4)

These comments go to any estimate of SC-GHG in the rule. DOE disagrees with commenters' assertion that the use of SC-GHG methodologies violates the Major Questions

Doctrine. First, DOE reiterates that the rule does not rely on the monetized climate benefits and would be economically justified regardless of the inclusion of the climate benefits that DOE projects would result from the standards. Second, through EPCA, Congress has directed DOE to set energy conservation standards applicable to covered products and has explicitly required DOE to determine whether a standard is economically justified by determining "whether the benefits of the standard exceed its burdens" based on listed considerations. (42 U.S.C. 6295(o)) The economic benefit of pollution reductions is a standard metric in cost benefit analysis of actions that significantly affect emissions, as appliance efficiency standards typically do due to their statutory focus on energy conservation (and both grid electricity and natural gas combustion have associated emissions of GHGs and other air pollutants). All presidential administrations since the Reagan Administration have required agencies to conduct cost benefit analyses in their rulemakings and have strongly encouraged the monetization of impacts where possible. The interagency working group developed federal SC-GHG estimates in 2010, and SC-GHG estimates have been used in federal agencies rulemakings for over a decade. DOE itself has used SC-GHG estimates in its rulemakings and other analyses since 2009. It is, in fact, difficult to see how DOE could justify not calculating such benefits where possible. DOE's use of SC-GHG estimates to provide a monetary estimate of the benefits of the GHG emissions reductions that are projected to result from the adoption of these efficiency standards is consistent with the statutory requirements, best economic practices, government-wide cost benefit analysis guidance, longstanding federal agency practices, data quality requirements, and current science. Additionally, it does not in any way assert a claim of authority concerning vast economic significance.

Regarding the comment about $671.4 million in SC-GHG benefits, the commenter appears to have misinterpreted this value as the benefits of SC-GHGs reductions of the proposed rule. In the proposed rule, at a 3% discount rate, the total benefits were estimated to be $1.25 billion, of which $174.4 million was attributed to climate benefits (calculated using the 2021 interim SC-GHG), , $738 million was from consumer operating cost savings, and the remainder was health benefits of other emissions reductions. At a 7% discount rate, the total benefits were estimated to be $1 billion, of which $174.4 million was attributed to climate benefits (calculated using the 2021 interim SC-GHG), , $586 million was from consumer operating cost savings, and the remainder was health benefits from other emissions. The climate benefits were thus not even the rule's largest monetized impact, and this rulemaking would be economically justified regardless of the inclusion of either set of estimates of the GHG emissions reductions.

Several commenters (Hussman Corporation, ALA et al., NAMA, and GAAS) criticized DOE's decision to first include the 2023 SC-GHG estimates in a NODA for an individual rule. Commenters criticized DOE for not dedicating a separate and comprehensive rulemaking to the use of the new methodologies in future agency analyses. Commenter (Hussman Corporation) opposed the metric being added in a NODA with a final rule due in four months and advocated that any SC-GHG considerations "should be handled by DOE as a discussion item for all appliances and not simply added during a proposed rulemaking for one product category." (Hussman Corporation, No. 108 at p. 3)

Commenter (ALA et al.) also urged DOE to evaluate its use of the 2023 SC-GHG methodologies in the anticipated rulemaking dedicated to reviewing and updating DOE's analytical methodology. ALA reiterated that vetting analytical method changes on issues as complex as SC-GHG is better done in a focused rulemaking rather than as part of a product-specific rulemaking on standards. (ALA et al., No. 109 at p. 2) Commenter (NAMA) stated that the new methodologies deserve an open and transparent discussion on how they will be applied before they are utilized in regulatory action. (NAMA, No. 112 at p. 4).

Commenter (GAAS) claimed that DOE's introduction of the SC-GHG within an electric appliance docket was an attempt to implement it without wide recognition or objection from other stakeholders that may be adversely impacted by the new methodologies. GAAS further deemed this decision, along with alleged policies of forced societal electrification, the "energy equivalent of ethnic cleansing." (GAAS, No. 96 at p. 6) Commenter (NAHB) stated that the DOE should increase transparency with regards to the process used to develop the new metric, stating that the process used to develop these estimates only involved parties invited to participate and that the choices made by these participants heavily affect the results. (NAHB, No. 103 at p. 4)

While DOE proposed in the August 2024 NODA to shift to the updated estimates, in this final rule, DOE is presenting climate benefits using both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates without relying on either set of values to justify its standards. By presenting both sets of estimates, DOE is simply providing additional information to the public regarding the estimated benefits of the final rule. Furthermore, DOE uses modeled estimates of values based on data inputs and analytical assumptions in its analyses all the time, from EIA projections of future energy supplies and prices, to estimates of costs of technologies over time. Here, DOE determined that public notice and comment is appropriate given the substantial interest in this topic, differences of opinion around various methodological choices, and the importance of the methodological updates underlying the new estimates. Multiple commenters did in fact comment on the August NODA solely on this topic, indicating that the public received notice of and had opportunity to comment on DOE's proposed preliminary decision to use the updated 2023 SC-GHG estimates.

Commenter (AEI) stated that the 2023 SC-GHG methodologies incorporate the co-benefits of regulating criteria and hazardous air pollutants in its calculations despite those pollutants being regulated independently under the Clean Air Act. Commenter raised concerns that accounting for the benefits of regulating these pollutants when they are already regulated improperly inflates the health benefits of GHG policies. (AEI, No. 97 at p. 8)

Both the 2021 interim SC-GHG estimates and the 2023 SC-GHG estimates account for the avoided harms of GHG emissions. Neither of the SC-GHG estimates incorporate the co-benefits of regulating fine particulates, other criteria air pollutants, or hazardous air pollutants. In its energy conservation rules, DOE separately estimates the resulting air pollution emissions reductions. DOE calculates the benefits from the reductions in sulfur dioxide, nitrogen oxides, nitrous oxide, and mercury, as well as greenhouse gases that result from the final rule. The benefits for each air pollutant are calculated separately, and none of the calculations include co-benefits from reducing the other pollutants.

Commenter (U.S. Chamber of Commerce et al.) stated that the significantly higher 2023 SC-GHG values could lead to overly stringent regulations and increased compliance costs for industries. Commenter further asserted that higher SC-GHG values could have a chilling effect on economic activity and that the change in methodologies could produce uncertainty that challenges businesses and investors. Commenter noted concerns with the 2021 interim SC-GHG estimates also, but ultimately recommended applying those values as opposed to the 2023 SC-GHG estimates. (U.S. Chamber of Commerce et al., No. 115 at pp. 5–6)

As stated previously, the standards in this rule do not rely on the monetized climate benefits and would be economically justified regardless of their use. Further, these standards would be economically justified using either the 2023 SC-GHG estimates or the 2021 interim SC-GHG estimates. As such, compliance costs for industries would be the same regardless of which SC-GHG metric is utilized and even if SC-GHG were not accounted for at all.

V.CDOE's derivations of the SC-CO2, SC-N2O, and SC-CH4 values used for this final rule are discussed in the following sections, and the results of DOE's analyses estimating the benefits of the reductions in emissions of these GHGs are presented in section V.B.6 of this document.

a. Social Cost of Carbon

The SC-CO_2 values used for this final rule are presented using two sets of SC-GHG estimates. One set is the 2023 SC-GHG estimates published by the EPA, which are shown in Table IV.21 in 5-year increments from 2020 to 2050. The full set of annual values that DOE used is presented in appendix 14A of the final rule TSD. These estimates include values out to 2080. DOE expects additional climate benefits to accrue for equipment still operating after 2080, but a lack of available SC-CO_2 estimates for emissions years beyond 2080 prevents DOE from monetizing these potential benefits in this analysis.

Table IV.21 Annual SC-CO_2 Values Based on 2023 SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton CO_2)

Emissions Year	Near-term Ramsey Discount Rate		
	2.5%	**2.0%**	**1.5%**
2020	117	193	337
2025	130	212	360
2030	144	230	384
2035	158	248	408
2040	173	267	431
2045	189	287	456
2050	205	308	482

DOE also presents results using interim SC-CO_2 values based on the values developed for the February 2021 SC-GHG TSD, which are shown in Table IV. in 5-year increments from 2020 to 2050. The set of annual values that DOE used, which was adapted from estimates published by EPA in 2021,[144] is presented in appendix 14A of the final rule TSD. These estimates are based on methods, assumptions, and parameters identical to the estimates published by the IWG (which were based on EPA modeling), and include values for 2051 to 2070.

[144] *See* EPA, *Revised 2023 and Later Model Year Light-Duty Vehicle GHG Emissions Standards: Regulatory Impact Analysis*, Washington, D.C., December 2021. Available at https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013ORN.pdf (last accessed Dec. 3, 2024).

Table IV.22. Annual $SC\text{-}CO_2$ Values Based on 2021 Interim SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton CO_2)

Year	Discount Rate and Statistic			
	5%	**3%**	**2.5%**	**3%**
	Average	**Average**	**Average**	**95th percentile**
2020	14	51	76	152
2025	17	56	83	169
2030	19	62	89	187
2035	22	67	96	206
2040	25	73	103	225
2045	28	79	110	242
2050	32	85	116	260

DOE multiplied the CO_2 emissions reduction estimated for each year by the $SC\text{-}CO_2$ value for that year in all cases. DOE adjusted the values to 2023$ using the implicit price deflator for gross domestic product ("GDP") from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in all cases using the specific discount rate that had been used to obtain the $SC\text{-}CO_2$ values in each case.

b. Social Cost of Methane and Nitrous Oxide

The $SC\text{-}CH_4$ and $SC\text{-}N_2O$ values used for this final rule are presented using two sets of SC-GHG estimates. One set is the 2023 SC-GHG estimates published by the EPA. Table IV.23 shows the updated sets of $SC\text{-}CH_4$ and $SC\text{-}N_2O$ estimates in 5-year increments from 2020 to 2050. The full set of annual values used is presented in appendix 14A of the final rule TSD. These estimates include values out to 2080.

Table IV.23 Annual SC-CH_4 and SC-N_2O Values Based on the 2023 SC-GHG estimates, 2020–2080 (2020$ per Metric Ton)

Emissions Year	SC-CH_4			SC-N_2O		
	Near-term Ramsey Discount Rate			Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%	2.5%	2.0%	1.5%
2020	1,257	1,648	2,305	35,232	54,139	87,284
2025	1,590	2,025	2,737	39,972	60,267	95,210
2030	1,924	2,403	3,169	44,712	66,395	103,137
2035	2,313	2,842	3,673	49,617	72,644	111,085
2040	2,702	3,280	4,177	54,521	78,894	119,032
2045	3,124	3,756	4,718	60,078	85,945	127,916
2050	3,547	4,231	5,260	65,635	92,996	136,799

DOE also presents results using interim SC-CH_4 and SC-N_2O values based on the values developed for the February 2021 SC-GHG TSD. Table IV.24 shows the updated sets of SC-CH_4 and SC-N_2O estimates from the latest interagency update in 5-year increments from 2020 to 2050. The full set of annual unrounded values used in the calculations is presented in appendix 14A of the final rule TSD. These estimates include values out to 2070.

Table IV.24 Annual SC-CH_4 and SC-N_2O Values Based on 2021 Interim SC-GHG Estimates, 2020–2050 (2020$ per Metric Ton)

Year	SC-CH_4				SC-N_2O			
	Discount Rate and Statistic				Discount Rate and Statistic			
	5%	3%	2.5%	3%	5%	3%	2.5 %	3%
	Average	Average	Average	95th percentile	Average	Average	Average	95th percentile
2020	670	1500	2000	3900	5800	18000	27000	48000
2025	800	1700	2200	4500	6800	21000	30000	54000
2030	940	2000	2500	5200	7800	23000	33000	60000
2035	1100	2200	2800	6000	9000	25000	36000	67000
2040	1300	2500	3100	6700	10000	28000	39000	74000
2045	1500	2800	3500	7500	12000	30000	42000	81000
2050	1700	3100	3800	8200	13000	33000	45000	88000

DOE multiplied the CH_4 and N_2O emissions reduction estimated for each year by the SC-CH_4 and SC-N_2O estimates for that year in each of the cases. DOE adjusted the values to 2023$ using the implicit price deflator for GDP from the Bureau of Economic Analysis. To calculate a present value of the stream of monetary values, DOE discounted the values in each of the cases using the specific discount rate that had been used to obtain the SC-CH_4 and SC-N_2O estimates in each case.

2. Monetization of Other Emissions Impacts

For the final rule, DOE estimated the monetized value of NO_X and SO_2 emissions reductions from electricity generation using benefit-per-ton estimates for that sector from EPA's Benefits Mapping and Analysis Program.[145] Table 5 of the EPA TSD provides a summary of the health impact endpoints quantified in the analysis. DOE used EPA's values for $PM_{2.5}$-related benefits associated with NO_X and SO_2 and for ozone-related benefits associated with NO_X for 2025, 2030, 2035, and 2040, calculated with discount rates of 3 percent and 7 percent. DOE used linear interpolation to define values for the years not given in the 2025 to 2040 period; for years beyond 2040, the values are held constant (rather than extrapolated) to be conservative. DOE combined the EPA regional benefit-per-ton estimates with regional information on electricity consumption and emissions from *AEO2023* to define weighted-average national values for NO_X and SO_2 (see appendix 14B of the final rule TSD).

[145] U.S. Environmental Protection Agency. Estimating the Benefit per Ton of Reducing Directly Emitted $PM_{2.5}$, $PM_{2.5}$ Precursors and Ozone Precursors from 21 Sectors. Available at *www.epa.gov/benmap/estimating-benefit-ton-reducing-directly-emitted-pm25-pm25-precursors-and-ozone-precursors.* (last accessed August 29, 2024)

DOE multiplied the site emissions reduction (in tons) in each year by the associated $/ton values, and then discounted each series using discount rates of 3 percent and 7 percent as appropriate.

M. Utility Impact Analysis

The utility impact analysis estimates the changes in installed electrical capacity and generation projected to result for each considered TSL. The analysis is based on published output from the NEMS associated with *AEO2023*. NEMS produces the *AEO* Reference case, as well as a number of side cases that estimate the economy-wide impacts of changes to energy supply and demand. For the current analysis, impacts are quantified by comparing the levels of electricity sector generation, installed capacity, fuel consumption, and emissions in the *AEO2023* Reference case and various side cases. Details of the methodology are provided in the appendices to chapter 15 of the final rule TSD.

The output of this analysis is a set of time-dependent coefficients that capture the change in electricity generation, primary fuel consumption, installed capacity and power sector emissions due to a unit reduction in demand for a given end use. These coefficients are multiplied by the stream of electricity savings calculated in the NIA to provide estimates of selected utility impacts of potential new or amended energy conservation standards.

N. Employment Impact Analysis

DOE considers employment impacts in the domestic economy as one factor in selecting a standard. Employment impacts from new or amended energy conservation standards include both direct and indirect impacts. Direct employment impacts are any changes in the number of employees of manufacturers of the equipment subject to standards, their suppliers, and related service firms. The MIA addresses those impacts. Indirect employment impacts are changes in national employment that occur due to the shift in expenditures and capital investment caused by the purchase and operation of more-efficient appliances. Indirect employment impacts from standards consist of the net jobs created or eliminated in the national economy, other than in the manufacturing sector being regulated, caused by: (1) reduced spending by consumers on energy, (2) reduced spending on new energy supply by the utility industry, (3) increased consumer spending on the equipment to which the new standards apply and other goods and services, and (4) the effects of those three factors throughout the economy.

One method for assessing the possible effects on the demand for labor of such shifts in economic activity is to compare sector employment statistics developed by the Labor Department's Bureau of Labor Statistics ("BLS"). BLS regularly publishes its estimates of the number of jobs per million dollars of economic activity in different sectors of the economy, as well as the jobs created elsewhere in the economy by this same economic activity. Data from BLS indicate that expenditures in the utility sector generally create fewer jobs (both directly and indirectly) than expenditures in other sectors of the economy.[146] Bureau of Economic Analysis input-output multipliers also show a lower labor intensity per million dollars of activity for utilities as compared to other industries.[147] There are many reasons for these differences, including wage differences and the fact that the utility sector is

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[146] *See* U.S. Bureau of Labor Statistics. Industry Output and Employment. Available at www.bls.gov/emp/data/industry-out-and-emp.htm (last accessed Aug. 19, 2024).
[147] *See* Regional Input-Output Modeling System (RIMS II) User's Guide. U.S. Department of Commerce–Bureau of Economic Analysis. Available at *bea.gov/resources/methodologies/RIMSII-user-guide* (last accessed Aug. 19, 2024).

more capital-intensive and less labor-intensive than other sectors. Energy conservation standards have the effect of reducing consumer utility bills. Because reduced consumer expenditures for energy likely lead to increased expenditures in other sectors of the economy, the general effect of efficiency standards is to shift economic activity from a less labor-intensive sector (*i.e.*, the utility sector) to more labor-intensive sectors (*e.g.*, the retail and service sectors). Thus, these data suggest that net national employment may increase due to shifts in economic activity resulting from energy conservation standards.

DOE estimated indirect national employment impacts for the standard levels considered in this final rule using an input/output model of the U.S. economy called Impact of Sector Energy Technologies version 4 ("ImSET").[148] ImSET is a special-purpose version of the "U.S. Benchmark National Input-Output" ("I-O") model, which was designed to estimate the national employment and income effects of energy-saving technologies. The ImSET software includes a computer-based I-O model having structural coefficients that characterize economic flows among 187 sectors most relevant to industrial, commercial, and residential building energy use.

DOE notes that ImSET is not a general equilibrium forecasting model, and that there are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Because ImSET does not incorporate price changes, the employment effects predicted by ImSET may overestimate actual job impacts over the long run for this

[148] Livingston, O. V., S. R.Bender, M. J.Scott, and R. W. Schultz. *ImSET 4.0: Impact of Sector Energy Technologies Model Description and User's Guide*. 2015. Pacific Northwest National Laboratory: Richland, WA. PNNL-24563.

rule. Therefore, DOE used ImSET only to generate results for near-term timeframes (2029-2033), where these uncertainties are reduced.

. For more details on the employment impact analysis, see chapter 16 of the final rule TSD.

V. Analytical Results and Conclusions

The following section addresses the results from DOE's analyses with respect to the considered energy conservation standards for CRE. It addresses the TSLs examined by DOE, the projected impacts of each of these levels if adopted as energy conservation standards for CRE, and the standards levels that DOE is adopting in this final rule. Additional details regarding DOE's analyses are contained in the final rule TSD supporting this document.

A. Trial Standard Levels

In general, DOE typically evaluates potential new or amended standards for equipment by grouping individual efficiency levels for each class into TSLs. Use of TSLs allows DOE to identify and consider manufacturer cost interactions between the equipment classes, to the extent that there are such interactions, and price elasticity of consumer purchasing decisions that may change when different standard levels are set.

In the analysis conducted for this final rule, DOE analyzed the benefits and burdens of five TSLs for CRE. DOE developed TSLs that combine efficiency levels for each analyzed equipment class. DOE presents the results for the TSLs in this document, while the results for all efficiency levels that DOE analyzed are in the final rule TSD. Table V.1 presents the TSLs and the corresponding efficiency levels that DOE has identified for potential amended energy conservation standards for CRE. TSL 5 represents the maximum technologically feasible ("max-tech") energy efficiency for all equipment classes. TSL 4 represents an intermediate TSL representing less stringent efficiency levels for approximately one-third of the equipment classes analyzed compared to TSL 5. TSL 3 represents less stringent efficiency levels for 12 equipment classes compared to TSL 4. TSL 2 represents another intermediate TSL, representing less stringent efficiency levels for 11 equipment classes, compared to TSL 3. TSL 1 represents the minimum efficiency level for most analyzed equipment classes. DOE considered all efficiency levels as part of its analysis.[149] Analytical results broken down by EL and equipment class are presented in chapters 8 and 10 of the final rule TSD.

[149] Efficiency levels that were analyzed for this final rule are discussed in section IV.C.1 of this document. Results by efficiency level are presented in chapters 8 and 10 of the final rule TSD.

Table V.1 Trial Standard Levels for CRE

Equipment Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
CB.SC.L	1	2	3	3	3
CB.SC.M	1	2	3	3	3
HCS.SC.L	1	1	1	1	1
HCS.SC.M	1	2	2	2	2
HCT.SC.I	1	2	2	2	6
HCT.SC.L	0	0	0	0	6
HCT.SC.M	0	0	0	0	5
HZO.RC.L	0	0	0	0	0
HZO.RC.M	0	0	0	0	0
HZO.SC.L	1	1	2	2	2
HZO.SC.M	1	1	2	2	2
SOC.RC.M	0	0	0	3	4
SOC.SC.M	1	3	5	7	7
SVO.RC.M	1	1	1	2	2
SVO.SC.M	1	3	4	5	5
VCS.SC.H	2	2	2	2	3
VCS.SC.I	1	2	3	3	3
VCS.SC.L	1	2	3	3	3
VCS.SC.M	1	1	1	2	2
VCT.RC.L	0	0	0	2	3
VCT.RC.M	0	0	0	3	4
VCT.SC.H	1	2	2	2	7
VCT.SC.I	0	0	0	0	3
VCT.SC.L	1	1	2	5	5
VCT.SC.M	1	1	2	4	6
VOP.RC.L	1	1	1	2	2
VOP.RC.M	1	1	1	2	2
VOP.SC.M	1	3	4	5	5

B. Economic Justification and Energy Savings

1. Economic Impacts on Individual Consumers

DOE analyzed the economic impacts on CRE consumers by looking at the effects that potential new and amended standards at each TSL would have on the LCC and PBP. DOE also examined the impacts of potential standards on selected consumer subgroups. These analyses are discussed in the following sections.

a. Life-Cycle Cost and Payback Period

In general, higher-efficiency equipment affect consumers in two ways: (1) purchase price increases, and (2) annual operating costs decrease. Inputs used for calculating the LCC and PBP include total installed costs (*i.e.*, equipment price plus installation costs), and operating costs (*i.e.*, annual energy use, energy prices, energy price trends, repair costs, and maintenance costs). The LCC calculation also uses equipment lifetime and a discount rate. Chapter 8 of the final rule TSD provides detailed information on the LCC and PBP analyses.

Table V.2 through Table V.57 show the LCC and PBP results for the TSLs considered for each equipment class. In the first of each pair of tables, the simple payback is measured relative to the baseline equipment. In the second table, the impacts are measured relative to the efficiency distribution in the no-new-standards case in the compliance year (see section IV.F.9 of this document). Because some consumers purchase equipment with higher efficiency in the no-new-standards case, the average savings are less than the difference between the average LCC of the baseline equipment and the average LCC at each TSL. The savings refer only to consumers who are affected by a standard at a given TSL. Those who already purchase equipment with efficiency at or above a given TSL are not affected. Consumers for whom the LCC increases at a given TSL experience a net cost.

Table V.2 Average LCC and PBP Results for CB.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	2,981.6	273.0	2,636.7	5,540.9	0.0	13.4
1	1	2,987.9	267.6	2,586.6	5,497.0	1.2	13.4
2	2	3,003.0	260.8	2,526.2	5,451.3	1.8	13.4
3-5	3	3,142.7	232.2	2,282.9	5,344.1	4.0	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.3 Average LCC Savings Relative to the No-New-Standards Case for CB.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	44.3	0%
2	2	75.4	0.3%
3-5	3	163.6	8.8%

* The savings represent the average LCC for affected consumers.

Table V.4 Average LCC and PBP Results for CB.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	2,335.2	106.0	1,042.1	3,317.1	0.0	13.3
1	1	2,341.6	102.6	1,011.6	3,292.7	1.9	13.3
2	2	2,356.7	98.4	975.5	3,271.4	2.8	13.3
3-5	3	2,496.4	82.4	854.6	3,286.6	6.8	13.3

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.5 Average LCC Savings Relative to the No-New-Standards Case for CB.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	24.6	0.1%
2	2	46.4	1.0%
3-5	3	8.1	26.2%

* The savings represent the average LCC for affected consumers.

Table V.6 Average LCC and PBP Results for HCS.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	1,674.1	64.4	627.5	2,256.4	0.0	13.4
1-5	1	1,687.8	60.1	590.3	2,232.5	3.2	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.7 Average LCC Savings Relative to the No-New-Standards Case for HCS.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-5	1	24.1	3.5%

* The savings represent the average LCC for affected consumers.

Table V.8 Average LCC and PBP Results for HCS.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	1,667.0	45.8	464.8	2,086.1	0.0	13.3
1	1	1,677.3	43.2	442.5	2,073.9	3.9	13.3
2-5	2	1,691.0	39.9	415.0	2,059.6	4.0	13.3

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.9 Average LCC Savings Relative to the No-New-Standards Case for HCS.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	12.4	3.0%
2-5	2	18.9	9.1%

* The savings represent the average LCC for affected consumers.

Table V.10 Average LCC and PBP Results for HCT.SC.I

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	1,536.5	129.5	1,308.4	2,807.6	0.0	13.5
1	1	1,609.7	119.2	1,209.9	2,780.5	7.1	13.5
2-4	2	1,622.0	117.3	1,192.1	2,774.7	7.0	13.5
--	3	1,761.5	104.3	1,097.5	2,816.2	8.9	13.5
--	4	1,850.0	103.2	1,074.2	2,879.3	11.9	13.5
--	5	1,870.1	102.7	1,069.1	2,893.8	12.5	13.5
5	6	2,110.6	101.4	1,057.2	3,116.5	20.5	13.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.11 Average LCC Savings Relative to the No-New-Standards Case for HCT.SC.I

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* ***2023$***	**Percent of Consumers that Experience Net Cost**
1	1	26.7	9.6%
2-4	2	29.3	10.4%
--	3	(24.9)	34.6%
--	4	(87.6)	41.2%
--	5	(99.9)	43.4%
5	6	(309.8)	58.8%

* The savings represent the average LCC for affected consumers.

Table V.12 Average LCC and PBP Results for HCT.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-4	0	1,443.6	80.6	823.4	2,230.4	0.0	13.4
--	1	1,516.8	74.4	764.9	2,243.1	11.9	13.4
--	2	1,529.1	73.4	755.0	2,245.2	11.9	13.4
--	3	1,617.7	72.3	731.7	2,308.3	21.1	13.4
--	4	1,637.8	72.0	728.4	2,324.6	22.5	13.4
--	5	1,777.2	70.4	744.8	2,476.9	32.9	13.4
5	6	2,017.6	69.6	737.3	2,703.7	52.6	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.13 Average LCC Savings Relative to the No-New-Standards Case for HCT.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* ***2023$***	**Percent of Consumers that Experience Net Cost**
--	1	(12.4)	18.3%
--	2	(13.0)	20.9%
--	3	(70.6)	48.5%
--	4	(86.1)	49.7%
--	5	(235.8)	52.3%
5	6	(430.4)	60.5%

* The savings represent the average LCC for affected consumers.

Table V.14 Average LCC and PBP Results for HCT.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		

1-4	0	1,372.5	37.5	407.5	1,741.6	0.0	13.3
--	1	1,445.6	35.6	389.6	1,794.8	38.6	13.3
--	2	1,457.9	35.2	385.9	1,803.1	37.4	13.3
--	3	1,546.4	34.2	362.8	1,866.0	52.0	13.3
--	4	1,566.5	34.0	361.5	1,884.3	55.8	13.3
5	5	1,806.9	33.7	358.7	2,115.1	114.9	13.3

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.15 Average LCC Savings Relative to the No-New-Standards Case for HCT.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
--	1	(53.4)	42.9%
--	2	(55.8)	48.3%
--	3	(95.4)	83.1%
--	4	(112.5)	84.3%
5	5	(340.7)	86.4%

* The savings represent the average LCC for affected consumers.

Table V.16 Average LCC and PBP Results for HZO.RC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-5	0	5,912.4	1,383.8	12,889.5	18,801.9	0.0	13.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.17 Average LCC Savings Relative to the No-New-Standards Case for HZO.RC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-5	0	0.00	0.0%

* The savings represent the average LCC for affected consumers.

Table V.18 Average LCC and PBP Results for HZO.RC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-5	0	5,914.4	616.9	5,803.3	11,717.7	0.0	13.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.19 Average LCC Savings Relative to the No-New-Standards Case for HZO.RC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-5	0	0.00	0.0%

* The savings represent the average LCC for affected consumers.

Table V.20 Average LCC and PBP Results for HZO.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	3,110.6	1,244.7	11,366.8	14,409.0	0.0	12.6
1-2	1	3,124.2	1,236.9	11,299.7	14,355.2	1.8	12.6
3-5	2	3,600.1	1,039.1	9,594.3	13,115.3	2.4	12.6

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.21 Average LCC Savings Relative to the No-New-Standards Case for HZO.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-2	1	54.0	0.03%
3-5	2	1,243.6	0.3%

* The savings represent the average LCC for affected consumers.

Table V.22 Average LCC and PBP Results for HZO.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	2,336.9	517.3	4,721.0	7,006.0	0.0	12.5
1-2	1	2,350.5	511.2	4,670.0	6,968.3	2.3	12.5
3-5	2	2,489.8	458.4	4,224.4	6,658.8	2.6	12.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.23 Average LCC Savings Relative to the No-New-Standards Case for HZO.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-2	1	39.2	0.1%
3-5	2	312.9	1.0%

* The savings represent the average LCC for affected consumers.

Table V.24 Average LCC and PBP Results for SOC.RC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-3	0	13,558.3	965.0	10,107.1	23,665.3	0.0	13.0
--	1	13,605.7	964.0	10,097.6	23,703.3	46.7	13.0
--	2	13,800.2	898.3	9,079.0	22,879.3	3.6	13.0
4	3	13,877.8	897.8	9,074.5	22,952.3	4.8	13.0
5	4	14,805.4	896.6	9,063.7	23,869.1	18.3	13.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.25 Average LCC Savings Relative to the No-New-Standards Case for SOC.RC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
--	1	(37.9)	11.8%
--	2	816.4	16.1%
4	3	743.4	16.1%
5	4	(181.4)	36.7%

* The savings represent the average LCC for affected consumers.

Table V.26 Average LCC and PBP Results for SOC.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	7,798.4	436.0	4,382.6	12,014.9	0.0	12.5
1	1	7,822.4	382.8	3,914.1	11,569.8	0.5	12.5
--	2	7,839.4	377.8	3,873.5	11,545.8	0.7	12.5
2	3	7,846.4	371.6	3,818.9	11,498.2	0.7	12.5
--	4	7,985.6	351.0	3,662.7	11,478.2	2.2	12.5
3	5	8,001.5	350.4	3,657.1	11,488.1	2.4	12.5
--	6	8,196.0	332.4	3,348.5	11,369.9	3.8	12.5

4-5	7	8,531.0	331.7	3,342.4	11,691.6	7.0	12.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.27 Average LCC Savings Relative to the No-New-Standards Case for SOC.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	441.5	0.0%
--	2	448.3	0.2%
2	3	481.5	0.0%
--	4	453.4	3.1%
3	5	443.5	3.7%
--	6	504.8	5.0%
4-5	7	183.2	22.8%

* The savings represent the average LCC for affected consumers.

Table V.28 Average LCC and PBP Results for SVO.RC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	6,955.4	1,267.3	12,496.0	19,451.3	0.0	13.1
1-3	1	7,145.5	1,187.6	12,211.7	19,357.3	2.4	13.1
4-5	2	7,366.6	1,149.6	11,596.2	18,962.8	3.5	13.1

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.29 Average LCC Savings Relative to the No-New-Standards Case for SVO.RC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-3	1	97.1	25.6%
4-5	2	473.0	14.6%

* The savings represent the average LCC for affected consumers.

Table V.30 Average LCC and PBP Results for SVO.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	4,229.1	1,020.4	9,486.6	13,624.4	0.0	12.5

1	1	4,292.4	946.4	8,994.5	13,194.3	0.9	12.5
--	2	4,305.1	933.1	8,878.1	13,090.3	0.9	12.5
2	3	4,335.3	916.6	8,737.1	12,978.8	1.0	12.5
3	4	4,981.2	835.2	8,032.2	12,905.9	4.1	12.5
4-5	5	5,096.1	823.5	7,844.0	12,830.1	4.4	12.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.31 Average LCC Savings Relative to the No-New-Standards Case for SVO.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	430.2	0.0%
--	2	493.8	0.0%
2	3	576.1	0.03%
3	4	578.9	11.8%
4-5	5	642.4	10.1%

* The savings represent the average LCC for affected consumers.

Table V.32 Average LCC and PBP Results for VCS.SC.H

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	4,216.4	82.5	853.1	4,963.1	0.0	13.5
--	1	4,222.8	80.0	831.9	4,948.1	2.6	13.5
1-4	2	4,237.9	77.1	807.5	4,938.5	4.0	13.5
5	3	4,377.6	66.0	732.2	4,999.3	9.8	13.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.33 Average LCC Savings Relative to the No-New-Standards Case for VCS.SC.H

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
--	1	0.0	0.0%
1-4	2	9.8	5.6%
5	3	(57.7)	58.9%

* The savings represent the average LCC for affected consumers.

Table V.34 Average LCC and PBP Results for VCS.SC.I

TSL	Efficiency Level	Average Costs *2023$*	Simple Payback	

		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	*years*	Average Lifetime *years*
--	0	4,875.2	679.7	6,528.2	11,270.1	0.0	13.4
1	1	4,881.6	674.3	6,478.4	11,226.5	1.2	13.4
2	2	4,896.7	667.6	6,418.4	11,181.2	1.8	13.4
3-5	3	5,176.0	583.0	5,676.1	10,710.6	3.1	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.35 Average LCC Savings Relative to the No-New-Standards Case for VCS.SC.I

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	45.1	0.0%
2	2	70.8	0.1%
3-5	3	488.2	3.9%

* The savings represent the average LCC for affected consumers.

Table V.36 Average LCC and PBP Results for VCS.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	4,441.3	475.8	4,560.5	8,879.8	0.0	13.3
1	1	4,447.6	470.4	4,510.8	8,836.2	1.2	13.3
2	2	4,462.7	463.6	4,450.8	8,791.0	1.8	13.3
3-5	3	4,602.4	401.5	3,892.7	8,368.7	2.2	13.3

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.37 Average LCC Savings Relative to the No-New-Standards Case for VCS.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	43.3	0.0%
2	2	88.0	0.1%
3-5	3	470.5	0.4%

* The savings represent the average LCC for affected consumers.

Table V.38 Average LCC and PBP Results for VCS.SC.M

TSL	Efficiency Level	Average Costs *2023$*	Simple Payback	

		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	*years*	Average Lifetime *years*
--	0	4,222.3	127.8	1,285.2	5,395.9	0.0	13.5
1-3	1	4,237.4	122.8	1,241.6	5,367.1	3.0	13.5
4-5	2	4,377.0	111.7	1,166.3	5,427.7	9.6	13.5

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.39 Average LCC Savings Relative to the No-New-Standards Case for VCS.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-3	1	29.1	3.1%
4-5	2	(42.0)	51.8%

* The savings represent the average LCC for affected consumers.

Table V.40 Average LCC and PBP Results for VCT.RC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-3	0	9,220.4	1,438.3	14,513.2	23,733.5	0.0	14.0
--	1	9,441.7	1,414.5	14,122.1	23,563.9	9.3	14.0
4	2	9,715.5	1,408.7	14,064.8	23,780.3	16.8	14.0
5	3	12,989.5	1,372.5	13,708.1	26,697.6	57.3	14.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.41 Average LCC Savings Relative to the No-New-Standards Case for VCT.RC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
--	1	174.2	3.5%
4	2	(182.9)	69.8%
5	3	(3,080.4)	85.6%

* The savings represent the average LCC for affected consumers.

Table V.42 Average LCC and PBP Results for VCT.RC.M

TSL	Efficiency Level	Average Costs *2023$*	Simple Payback	

		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC	*years*	Average Lifetime *years*
1-3	0	9,014.1	488.0	5,268.2	14,282.3	0.0	14.0
--	1	9,181.5	482.0	5,209.0	14,390.5	27.8	14.0
--	2	9,402.9	455.9	4,795.9	14,198.7	12.1	14.0
4	3	9,676.6	454.6	4,782.5	14,459.1	19.8	14.0
5	4	12,949.6	451.3	4,751.0	17,700.6	107.3	14.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.43 Average LCC Savings Relative to the No-New-Standards Case for VCT.RC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
--	1	(108.5)	8.7%
--	2	170.3	10.6%
4	3	(108.3)	31.6%
5	4	(3,333.3)	55.9%

* The savings represent the average LCC for affected consumers.

Table V.44 Average LCC and PBP Results for VCT.SC.H

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	4,570.0	122.2	1,310.6	5,763.6	0.0	13.4
1	1	4,576.3	119.8	1,289.6	5,748.7	2.7	13.4
2-4	2	4,591.4	116.9	1,265.3	5,739.2	4.0	13.4
--	3	4,730.9	102.6	1,158.7	5,768.5	8.2	13.4
--	4	4,797.8	101.1	1,145.2	5,820.2	10.8	13.4
--	5	4,913.0	98.3	1,088.9	5,876.1	14.3	13.4
--	6	5,022.5	97.8	1,084.5	5,978.4	18.6	13.4
5	7	6,332.0	96.8	1,074.2	7,244.1	69.2	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.45 Average LCC Savings Relative to the No-New-Standards Case for VCT.SC.H

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	14.6	1.0%
2-4	2	19.3	7.0%

--	3	(16.1)	35.8%
--	4	(67.8)	41.4%
--	5	(113.4)	54.2%
--	6	(201.5)	69.3%
5	7	(1,467.3)	72.7%

* The savings represent the average LCC for affected consumers.

Table V.46 Average LCC and PBP Results for VCT.SC.I

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
1-2	0	6,919.6	808.7	7,881.5	14,631.6	0.0	13.4
3	1	7,034.7	806.5	7,825.6	14,688.0	51.7	13.4
--	2	7,144.2	801.3	7,777.1	14,746.3	30.5	13.4
4	3	8,453.6	769.4	7,475.0	15,721.5	39.0	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.47 Average LCC Savings Relative to the No-New-Standards Case for VCT.SC.I

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
3	1	(57.0)	2.0%
--	2	(68.7)	11.2%
4	3	(990.6)	48.0%

* The savings represent the average LCC for affected consumers.

Table V.48 Average LCC and PBP Results for VCT.SC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	6,788.8	673.4	6,539.3	13,137.6	0.0	13.4
1-2	1	6,803.9	666.7	6,479.3	13,092.3	2.2	13.4
3	2	7,082.9	588.1	5,793.8	12,677.9	3.5	13.4
--	3	7,198.1	585.3	5,737.9	12,733.9	4.6	13.4
--	4	7,307.6	582.5	5,711.7	12,814.2	5.7	13.4
4-5	5	8,617.3	565.4	5,548.8	13,924.3	16.9	13.4

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.49 Average LCC Savings Relative to the No-New-Standards Case for VCT.SC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-2	1	45.2	0.4%
3	2	436.9	7.2%
--	3	380.6	11.0%
--	4	300.3	20.5%
4-5	5	(809.8)	82.7%

* The savings represent the average LCC for affected consumers.

Table V.50 Average LCC and PBP Results for VCT.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	4,580.6	203.7	2,069.4	6,540.2	0.0	13.3
1-2	1	4,595.7	198.7	2,026.6	6,512.2	3.1	13.3
3	2	4,735.2	179.9	1,879.5	6,501.1	6.5	13.3
--	3	4,802.1	177.5	1,856.9	6,543.9	8.5	13.3
4	4	4,917.2	174.7	1,801.0	6,600.4	11.6	13.3
--	5	5,026.7	173.9	1,793.7	6,700.0	15.0	13.3
5	6	6,336.2	172.1	1,776.6	7,960.8	55.6	13.3

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.51 Average LCC Savings Relative to the No-New-Standards Case for VCT.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-2	1	28.0	2.7%
3	2	33.2	25.3%
--	3	(9.9)	38.2%
4	4	(66.0)	44.6%
--	5	(165.4)	51.5%
5	6	(1,421.6)	61.3%

* The savings represent the average LCC for affected consumers.

Table V.52 Average LCC and PBP Results for VOP.RC.L

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	9,692.4	4,493.8	42,696.1	52,388.5	0.0	13.0

1-3	1	9,882.5	4,283.3	41,193.3	51,075.8	0.9	13.0
4-5	2	10,103.6	4,235.7	40,431.7	50,535.3	1.6	13.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.53 Average LCC Savings Relative to the No-New-Standards Case for VOP.RC.L

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-3	1	1,300.4	0.00%
4-5	2	1,529.7	3.1%

* The savings represent the average LCC for affected consumers.

Table V.54 Average LCC and PBP Results for VOP.RC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	8,838.5	1,632.2	16,060.5	24,898.9	0.0	13.0
1-3	1	9,028.7	1,525.8	15,526.0	24,554.7	1.8	13.0
4-5	2	9,249.8	1,478.2	14,764.8	24,014.6	2.7	13.0

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.55 Average LCC Savings Relative to the No-New-Standards Case for VOP.RC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1-3	1	337.4	4.1%
4-5	2	798.0	7.5%

* The savings represent the average LCC for affected consumers.

Table V.56 Average LCC and PBP Results for VOP.SC.M

TSL	Efficiency Level	Average Costs *2023$*				Simple Payback *years*	Average Lifetime *years*
		Installed Cost	First Year's Operating Cost	Lifetime Operating Cost	LCC		
--	0	6,623.6	1,264.5	11,857.3	18,337.8	0.0	12.6
1	1	6,687.0	1,171.3	11,189.4	17,731.8	0.7	12.6
--	2	6,705.9	1,151.5	11,014.4	17,575.4	0.7	12.6
2	3	6,751.2	1,126.8	10,802.6	17,407.8	0.9	12.6
3	4	7,029.7	981.9	9,545.7	16,423.4	1.4	12.6

4-5	5	7,171.2	967.5	9,306.7	16,322.9	1.8	12.6

Note: The results for each TSL are calculated assuming that all consumers use equipment at that efficiency level. The PBP is measured relative to the baseline product.

Table V.57 Average LCC Savings Relative to the No-New-Standards Case for VOP.SC.M

TSL	Efficiency Level	Life-Cycle Cost Savings	
		Average LCC Savings* *2023$*	Percent of Consumers that Experience Net Cost
1	1	604.6	0.0%
--	2	760.5	0.0%
2	3	915.5	0.0%
3	4	1,867.5	0.0%
4-5	5	1,945.9	0.3%

* The savings represent the average LCC for affected consumers.

b. Consumer Subgroup Analysis

In the consumer subgroup analysis, DOE estimated the impact of the considered TSLs on small businesses. Table V.58 compares the average LCC savings and PBP at each efficiency level for small businesses with the entire consumer sample for CRE. In most cases, the average LCC savings and PBP for small businesses at the considered efficiency levels are not substantially different from the average for all businesses. Chapter 11 of the final rule TSD presents the complete LCC and PBP results for the subgroup.

Table V.58 Average LCC and PBP Results Comparison for Small Businesses for CRE

Equipment Class		EL	Average LCC Savings		Simple Payback Period		Net Cost	
			2023$		*years*		*%*	
			Small Business	Ref. Case	Small Business	Ref. Case	Small Business	Ref. Case
CB.SC.L	1	1	46.7	44.3	1.0	1.2	0%	0%
	2	2	80.3	75.4	1.4	1.8	0%	0%
	3-5	3	182.7	163.6	3.2	4.0	3%	9%
CB.SC.M	1	1	26.4	24.6	1.5	1.9	0%	0%
	2	2	50.7	46.4	2.3	2.8	0%	1%
	3-5	3	21.9	8.1	5.5	6.8	17%	26%
HCS.SC.L	1-5	1	26.3	24.1	2.6	3.2	0%	4%

HCS.SC.M	1	1	14.1	12.4	3.2	3.9	1%	3%
	2-5	2	21.7	18.9	3.3	4.0	4%	9%
HCT.SC.I	1	1	31.1	26.7	5.8	7.1	2%	10%
	2-4	2	34.0	29.3	5.7	7.0	2%	10%
	--	3	(12.6)	(24.9)	7.3	8.9	31%	35%
	--	4	(77.2)	(87.6)	9.7	11.9	44%	41%
	--	5	(89.6)	(99.9)	10.2	12.5	46%	43%
	5	6	(301.0)	(309.8)	16.7	20.5	59%	59%
HCT.SC.L	--	1	(9.8)	(12.4)	9.6	11.9	20%	18%
	--	2	(10.3)	(13.0)	9.6	11.9	22%	21%
	--	3	(70.8)	(70.6)	17.1	21.1	50%	49%
	--	4	(86.2)	(86.1)	18.3	22.5	51%	50%
	--	5	(231.0)	(235.8)	26.7	32.9	52%	52%
	5	6	(426.6)	(430.4)	42.7	52.6	61%	61%
HCT.SC.M	--	1	(52.7)	(53.4)	31.4	38.6	43%	43%
	--	2	(55.0)	(55.8)	30.4	37.4	48%	48%
	--	3	(96.7)	(95.4)	42.3	52.0	83%	83%
	--	4	(113.8)	(112.5)	45.5	55.8	84%	84%
	5	5	(342.6)	(340.7)	93.6	114.9	86%	86%
HZO.SC.L	1-2	1	59.4	54.0	1.4	1.8	0%	0%
	3-5	2	1,384.4	1,243.6	1.9	2.4	0%	0%
HZO.SC.M	1-2	1	43.2	39.2	1.8	2.3	0%	0%
	3-5	2	353.3	312.9	2.1	2.6	0%	1%
SOC.RC.M	--	1	(37.3)	(37.9)	37.8	46.7	12%	12%
	--	2	798.4	816.4	2.9	3.6	16%	16%
	4	3	725.7	743.4	3.8	4.8	16%	16%
	5	4	(198.1)	(181.4)	14.8	18.3	31%	37%
SOC.SC.M	1	1	477.3	441.5	0.4	0.5	0%	0%
	--	2	486.6	448.3	0.6	0.7	0%	0%
	2	3	522.8	481.5	0.6	0.7	0%	0%
	--	4	507.8	453.4	1.8	2.2	1%	3%
	3	5	498.3	443.5	1.9	2.4	2%	4%
	--	6	542.9	504.8	3.1	3.8	4%	5%
	4-5	7	220.9	183.2	5.7	7.0	18%	23%
SVO.RC.M	1-3	1	218.7	97.1	1.9	2.4	3%	26%
	4-5	2	557.2	473.0	2.8	3.5	12%	15%
SVO.SC.M	1	1	507.5	430.2	0.7	0.9	0%	0%
	--	2	573.0	493.8	0.7	0.9	0%	0%
	2	3	662.7	576.1	0.8	1.0	0%	0%
	3	4	710.4	578.9	3.3	4.1	4%	12%
	4-5	5	766.1	642.4	3.6	4.4	3%	10%
VCS.SC.H	--	1	0.0	0.0	2.2	2.6	0%	0%
	1-4	2	11.5	9.8	3.2	4.0	4%	6%
	5	3	(48.4)	(57.7)	8.0	9.8	62%	59%
VCS.SC.I	1	1	47.7	45.1	1.0	1.2	0%	0%
	2	2	75.6	70.8	1.4	1.8	0%	0%

	3-5	3	533.8	488.2	2.5	3.1	0%	4%
VCS.SC.L	1	1	46.1	43.3	1.0	1.2	0%	0%
	2	2	94.6	88.0	1.4	1.8	0%	0%
	3-5	3	506.3	470.5	1.8	2.2	0%	0%
VCS.SC.M	1-3	1	31.4	29.1	2.5	3.0	0%	3%
	4-5	2	(32.2)	(42.0)	7.9	9.6	51%	52%
VCT.RC.L	--	1	157.3	174.2	7.6	9.3	4%	4%
	4	2	(183.9)	(182.9)	13.6	16.8	69%	70%
	5	3	(3,067.5)	(3,080.4)	46.6	57.3	86%	86%
VCT.RC.M	--	1	(106.0)	(108.5)	22.6	27.8	9%	9%
	--	2	157.8	170.3	9.8	12.1	11%	11%
	4	3	(118.9)	(108.3)	16.1	19.8	29%	32%
	5	4	(3,340.9)	(3,333.3)	87.2	107.3	56%	56%
VCT.SC.H	1	1	16.0	14.6	2.2	2.7	0%	1%
	2-4	2	22.0	19.3	3.3	4.0	3%	7%
	--	3	(3.7)	(16.1)	6.7	8.2	29%	36%
	--	4	(55.0)	(67.8)	8.8	10.8	43%	41%
	--	5	(106.1)	(113.4)	11.7	14.3	58%	54%
	--	6	(195.3)	(201.5)	15.1	18.6	72%	69%
	5	7	(1,464.5)	(1,467.3)	56.3	69.2	73%	73%
VCT.SC.I	--	1	(61.6)	(57.0)	42.2	51.7	2%	2%
	--	2	(67.5)	(68.7)	24.9	30.5	11%	11%
	5	3	(979.4)	(990.6)	31.8	39.0	48%	48%
VCT.SC.L	1-2	1	48.9	45.2	1.8	2.2	0%	0%
	3	2	480.3	436.9	2.8	3.5	1%	7%
	--	3	420.4	380.6	3.8	4.6	3%	11%
	--	4	340.9	300.3	4.6	5.7	7%	21%
	4-5	5	(766.2)	(809.8)	13.8	16.9	88%	83%
VCT.SC.M	1-2	1	31.0	28.0	2.5	3.1	0%	3%
	3	2	48.0	33.2	5.3	6.5	14%	25%
	--	3	5.5	(9.9)	6.9	8.5	30%	38%
	4	4	(54.4)	(66.0)	9.4	11.6	45%	45%
	--	5	(153.7)	(165.4)	12.2	15.0	56%	51%
	5	6	(1,413.1)	(1,421.6)	45.1	55.6	61%	61%
VOP.RC.L	1-3	1	1,515.0	1,300.4	0.7	0.9	0%	0%
	4-5	2	1,677.7	1,529.7	1.3	1.6	3%	3%
VOP.RC.M	1-3	1	480.8	337.4	1.4	1.8	0%	4%
	4-5	2	890.5	798.0	2.2	2.7	3%	7%
VOP.SC.M	1	1	691.4	604.6	0.6	0.7	0%	0%
	--	2	860.6	760.5	0.6	0.7	0%	0%
	2	3	1,031.3	915.5	0.8	0.9	0%	0%
	3	4	2,077.3	1,867.5	1.2	1.4	0%	0%
	4-5	5	2,146.3	1,945.9	1.5	1.8	0%	0%

Notes: The results for each EL are calculated assuming that all consumers use products at that efficiency level. The PBP is measured relative to the baseline product. The savings represent the average LCC savings for affected consumers.

c. Rebuttable Presumption Payback

As discussed in section IV.F.10 of this document, EPCA establishes a rebuttable presumption that an energy conservation standard is economically justified if the increased purchase cost for CRE that meets the standard is less than three times the value of the first-year energy savings resulting from the standard. In calculating a rebuttable presumption payback period for each of the considered TSLs, DOE used discrete values, and, as required by EPCA, based the energy use calculation on the DOE test procedures for CRE. In contrast, the PBPs presented in section V.B.1.a of this document were calculated using distributions that reflect the range of energy use in the field.

Table V.59 presents the rebuttable-presumption payback periods for the considered TSLs for CRE. While DOE examined the rebuttable-presumption criterion, it considered whether the standard levels considered for this rule are economically justified through a more detailed analysis of the economic impacts of those levels, pursuant to 42 U.S.C. 6316(e)(1) and 42 U.S.C. 6295(o)(2)(B)(i), that considers the full range of impacts to the consumer, manufacturer, Nation, and environment. The results of that analysis serve as the basis for DOE to definitively evaluate the economic justification for a potential standard level, thereby supporting or rebutting the results of any preliminary determination of economic justification.

Table V.59 Rebuttable-Presumption Payback Periods

Rebuttable Payback Period <u>*years*</u>							
Equipment Class	**EL 1**	**EL 2**	**EL 3**	**EL 4**	**EL 5**	**EL 6**	**EL 7**
CB.SC.L	1.1	1.6	3.6				
CB.SC.M	1.6	2.5	6.2				

HCS.SC.L	2.9						
HCS.SC.M	3.7	3.8					
HCT.SC.I	6.4	6.4	8.0	10.7	11.3	18.4	
HCT.SC.L	10.3	10.3	18.4	19.7	29.1	46.9	
HCT.SC.M	37.0	36.0	48.9	49.1	100.0		
HZO.SC.L	1.6	2.2					
HZO.SC.M	2.0	2.4					
SOC.RC.M	40.0	3.3	4.4	16.8			
SOC.SC.M	0.4	0.6	0.7	2.0	2.2	3.5	6.5
SVO.RC.M	2.2	3.2					
SVO.SC.M	0.8	0.8	0.9	3.7	4.1		
VCS.SC.H	2.3	3.6	8.9				
VCS.SC.I	1.0	1.6	2.8				
VCS.SC.L	1.1	1.6	2.0				
VCS.SC.M	2.7	8.7					
VCT.RC.L	8.5	15.1	51.9				
VCT.RC.M	24.9	10.9	17.8	96.7			
VCT.SC.H	2.3	3.6	7.4	9.8	13.0	16.6	61.9
VCT.SC.I	48.6	27.1	35.3				
VCT.SC.L	2.0	3.1	4.2	5.1	15.2		
VCT.SC.M	2.7	5.8	7.6	10.4	13.4	49.9	
VOP.RC.L	0.8	1.5					
VOP.RC.M	1.6	2.5					
VOP.SC.M	0.6	0.7	0.9	1.3	1.7		

2. Economic Impacts on Manufacturers

DOE performed an MIA to estimate the impact of new and amended energy conservation standards on manufacturers of CRE. The next section describes the expected impacts on manufacturers at each considered TSL. Chapter 12 of the final rule TSD explains the analysis in further detail.

a. Industry Cash Flow Analysis Results

In this section, DOE provides GRIM results from the analysis, which examines changes in the industry that would result from a standard. Table V.60 summarizes the estimated financial impacts (represented by changes in INPV) of potential new and amended energy conservation standards on manufacturers of CRE, as well as the conversion costs that DOE estimates manufacturers of CRE would incur at each TSL.

The impact of potential new and amended energy conservation standards was analyzed under two scenarios: (1) the preservation-of-gross-margin percentage scenario; and (2) the preservation-of-operating-profit scenario, as discussed in section IV.J.2.d of this document. The preservation-of-gross-margin percentage scenario applies a "gross-margin percentage" of 28 percent for all equipment classes across all efficiency levels.[150] This scenario assumes that a manufacturer's per-unit dollar profit would increase as MPCs increase in the standards cases and represents the upper-bound to industry profitability under potential new and amended energy conservation standards.

The preservation-of-operating-profit scenario reflects manufacturers' concerns about their inability to maintain margins as MPCs increase to reach more stringent efficiency levels. In this scenario, while manufacturers make the necessary investments required to convert their facilities to produce compliant equipment, operating profit does not change in absolute dollars and decreases as a percentage of revenue. The preservation-of-operating-profit scenario represents the lower (or more severe) bound to industry profitability under potential new or amended energy conservation standards.

[150] The gross-margin percentage of 28 percent is based on a manufacturer markup of 1.38.

Each of the modeled scenarios resulted in a unique set of cash flows and corresponding INPV for each TSL. 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). The "change in INPV" results refer to the difference in industry value between the no-new-standards case and standards case at each TSL. To provide perspective on the short-run cash flow impact, DOE includes a comparison of free cash flow between the no-new-standards case and the standards case at each TSL in the year before new and amended standards would take effect. This figure provides an understanding of the magnitude of the required conversion costs relative to the cash flow generated by the industry in the no-new-standards case.

Conversion costs are one-time investments for manufacturers to bring their manufacturing facilities and equipment designs into compliance with potential new and amended standards. As described in section IV.J.2.c of this document, conversion cost investments occur between the year of publication of the final rule and the year by which manufacturers must comply with the new and amended standards. The conversion costs can have a significant impact on the short-term cash flow in the industry and generally result in lower free cash flow in the period between publication of the final rule and the compliance date of potential new and amended standards. Conversion costs are independent of the manufacturer markup scenarios and are not presented as a range in this analysis.

Table V.60 Manufacturer Impact Analysis Results

	Unit	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
INPV	*2023$ Million*	3,022.3	2,997.6 to 3,001.5	2,994.8 to 2,999.2	2,943.6 to 2,971.0	2,862.2 to 2,958.8	2,800.6 to 3,077.5
Change in INPV*	*2023$ Million*	-	(24.7) to (20.8)	(27.5) to (23.1)	(78.7) to (51.3)	(160.1) to (63.5)	(221.7) to 55.2
	%	-	(0.8) to (0.7)	(0.9) to (0.8)	(2.6) to (1.7)	(5.3) to (2.1)	(7.3) to 1.8
Free Cash flow (2028)	*2023$ Million*	262.6	248.6	246.9	221.0	184.4	173.9
Change in Free Cash flow (2028)*	*%*	-	(5.4)	(6.0)	(15.9)	(29.8)	(33.8)
Product Conversion Costs	*2023$ Million*	-	42.0	46.4	98.5	196.4	223.5
Capital Conversion Costs	*2023$ Million*	-	0.0	0.3	19.1	27.5	30.6
Total Conversion Costs	*2023$ Million*	-	42.0	46.7	117.7	233.9	254.1

*Parentheses denote negative (-) values.

The following cash flow discussion refers to the TSLs as detailed in section V.A of this document. Table V. Table V.61 through Table V.64 show the design options analyzed in the engineering analysis for each directly analyzed equipment class by TSL. See section IV.C of this document and chapter 5 of the final rule TSD for additional information on the engineering analysis.

Table V.61 Incremental Design Options Analyzed as Compared to Baseline by Trial Standard Level for Vertical Equipment Families

Equipment Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
VOP.RC.M	Night curtains			Occupancy Sensors with Dimming	
VOP.RC.L	Night curtains			Occupancy Sensors with Dimming	
VOP.SC.M	Night Curtains	Brushless Direct Current (“BLDC”)	VSC	Occupancy Sensors with Dimming	

<table>
<tr><th>Equipment Class</th><th>TSL 1</th><th>TSL 2</th><th>TSL 3</th><th>TSL 4</th><th>TSL 5</th></tr>
<tr><td></td><td></td><td>Condenser Fan Motor</td><td></td><td colspan="2"></td></tr>
<tr><td>VCT.RC.M</td><td colspan="3">Baseline</td><td>Occupancy Sensors with Dimming; Triple Pane Krypton-Fill Door</td><td>Vacuum Insulated Glass Door (“VIG”)</td></tr>
<tr><td>VCT.RC.L</td><td colspan="3">Baseline</td><td>Occupancy Sensors with Dimming; Triple Pane Krypton-Fill Door</td><td>VIG</td></tr>
<tr><td>VCT.SC.H</td><td>Permanent Split Capacitator (“PSC”) Condenser Fan Motor</td><td colspan="3">BLDC Condenser Fan Motor</td><td>VSC; Occupancy Sensors with Dimming; VIG</td></tr>
<tr><td>VCT.SC.M</td><td colspan="2">BLDC Condenser Fan Motor</td><td>VSC</td><td>Triple Pane Argon-Fill Door; Occupancy Sensors with Dimming</td><td>VIG</td></tr>
<tr><td>VCT.SC.L</td><td colspan="2">BLDC Condenser Fan Motor</td><td>VSC</td><td colspan="2">Occupancy Sensors with Dimming; VIG</td></tr>
<tr><td>VCT.SC.I</td><td colspan="4">Baseline</td><td>Occupancy Sensors with Dimming; VIG</td></tr>
<tr><td>VCS.SC.H</td><td colspan="4">BLDC Condenser Fan Motor</td><td>VSC</td></tr>
<tr><td>VCS.SC.M</td><td colspan="3">BLDC Condenser Fan Motor</td><td colspan="2">VSC</td></tr>
<tr><td>VCS.SC.L</td><td>PSC Condenser Fan Motor</td><td>BLDC Condenser Fan Motor</td><td colspan="3">VSC</td></tr>
<tr><td>VCS.SC.I</td><td>PSC Condenser Fan Motor</td><td>BLDC Condenser Fan Motor</td><td colspan="3">VSC</td></tr>
</table>

Note: Design options are cumulative (*i.e.*, added as TSLs increase), except for component replacements of a design option at a lower TSL (*i.e.,* switching from a double pane door to a triple pane door, a triple-pane door to a VIG door, single-speed compressor to a variable speed compressor, or a PSC motor to a BLDC motor).

Table V.62 Incremental Design Options Analyzed as Compared to Baseline by Trial Standard Level for Semi-Vertical, Open, and Service Over-Counter Equipment Families

<table>
<tr><th>Equipment Class</th><th>TSL 1</th><th>TSL 2</th><th>TSL 3</th><th>TSL 4</th><th>TSL 5</th></tr>
<tr><td>SVO.RC.M</td><td colspan="3">Night Curtains</td><td colspan="2">Occupancy Sensors with Dimming</td></tr>
<tr><td>SVO.SC.M</td><td>Night Curtains</td><td>BLDC Condenser Fan Motor</td><td>VSC</td><td colspan="2">Occupancy Sensors with Dimming</td></tr>
<tr><td>SOC.RC.M</td><td colspan="3">Baseline</td><td>Occupancy Sensors with Dimming; Triple Pane, Krypton-Fill Door</td><td>VIG</td></tr>
<tr><td>SOC.SC.M</td><td>BLDC Evaporator Fan Motor</td><td>BLDC Condenser Fan Motor</td><td>VSC; Triple Pane, Argon-Fill Door</td><td colspan="2">Occupancy Sensors with Dimming; VIG</td></tr>
</table>

Note: Design options are cumulative (*i.e.*, added as TSLs increase), except for component replacements of a design option at a lower TSL (*i.e.,* switching from double pane door to triple pane door, a triple-pane door to a VIG door, a single-speed compressor to a variable-speed compressor, a PSC motor to a BLDC motor).

Table V.63 Incremental Design Options Analyzed as Compared to Baseline by Trial Standard Level for Horizontal Equipment Families

<table>
<tr><th>Equipment Class</th><th>TSL 1</th><th>TSL 2</th><th>TSL 3</th><th>TSL 4</th><th>TSL 5</th></tr>
<tr><td>HZO.RC.M</td><td colspan="5">Baseline</td></tr>
<tr><td>HZO.RC.L</td><td colspan="5">Baseline</td></tr>
<tr><td>HZO.SC.M</td><td colspan="2">BLDC Condenser Fan Motor</td><td colspan="3">VSC</td></tr>
<tr><td>HZO.SC.L</td><td colspan="2">BLDC Condenser Fan Motor</td><td colspan="3">VSC</td></tr>
<tr><td>HCT.SC.M</td><td colspan="4">Baseline</td><td>Occupancy Sensors with Dimming; VIG</td></tr>
<tr><td>HCT.SC.L</td><td colspan="4">Baseline</td><td>Occupancy Sensors with Dimming; VSC; VIG</td></tr>
<tr><td>HCT.SC.I</td><td>Double Pane, Argon-Fill Door</td><td colspan="3">Triple Pane, Argon-Fill Door</td><td>VSC; Occupancy Sensors with</td></tr>
</table>

					Dimming; VIG
HCS.SC.M	PSC Condenser Fan Motor	BLDC Condenser Fan Motor			
HCS.SC.L	BLDC Condenser Fan Motor				

Note: Design options are cumulative (*i.e.*, added as TSLs increase), except for component replacements of design option(s) at lower TSLs (*i.e.,* switching from a double pane door to a triple pane door, a triple-pane door to a VIG door, a single-speed compressor to a variable speed compressor, or a PSC motor to a BLDC motor).

Table V.64 Incremental Design Options Analyzed as Compared to Baseline by Trial Standard Level for Chef Base or Griddle Stand Equipment Classes

Equipment Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
CB.SC.M	PSC Condenser Fan Motor	BLDC Condenser Fan Motor	VSC		
CB.SC.L	PSC Condenser Fan Motor	BLDC Condenser Fan Motor	VSC		

Note: Design options are cumulative (*i.e.*, added as TSLs increase), except for component replacements of a design options at a lower TSL (*i.e.,* switching from a PSC motor to a BLDC motor or a single-speed compressor to a variable speed compressor).

At TSL 5, the standard represents the max-tech efficiencies for all equipment classes. The change in INPV is expected to range from -$221.7 million to $55.2 million, which represents a change in INPV of -7.3 percent to 1.8 percent, respectively. At this level, free cash flow is estimated to decrease by 33.8 percent compared to the no-new-standards case value of $262.6 million in the year 2028, the year before compliance would be required. In 2028, approximately 30.5 percent of covered CRE shipments are expected to meet the efficiencies required at TSL 5. See Table V. for the percent of equipment class shipments that would meet or exceed the efficiencies required at each TSL in 2028 (a year before the modeled compliance year).

The design options DOE analyzed at TSL 5 included the max-tech technologies for all equipment classes. For all semi-vertical and vertical open and transparent door equipment classes, DOE expects manufacturers would likely incorporate occupancy sensors with dimming capability. Open equipment classes would also likely necessitate the use of night curtains. For equipment classes with transparent doors, DOE expects manufacturers would likely need to incorporate vacuum-insulated glass doors. For most self-contained equipment classes, DOE expects manufacturers would need to incorporate BLDC condenser fan motors and variable-speed compressors. Of the 28 directly analyzed equipment classes, 5 equipment classes (VSC.SC.L, VCS.SC.M, VCT.RC.M, VCT.SC.L, and VCT.SC.M) account for approximately 81.5 percent of industry shipments covered by this final rule. For VCS.SC.L, TSL 5 corresponds to EL 3. For VCS.SC.M, TSL 5 corresponds to EL 2. For VCT.RC.M, TSL 5 corresponds to EL 4. For VCT.SC.L, TSL 5 corresponds to EL 5 and VCT.SC.M, TSL 5 corresponds to EL 6. See section V.A of this document for more information on the efficiency levels analyzed at each TSL.

At max-tech, DOE expects that nearly all manufacturers would need to dedicate notable engineering resources to update equipment designs and source, qualify, and test high-efficiency components across their CRE portfolio. However, most design options analyzed involve more efficient components (*e.g.*, high-efficiency motors) and would not necessitate significant capital investment. At this level, DOE estimates that approximately 55 percent of analyzed equipment class model listings (10,957 out of 19,902 unique basic models) do not meet the efficiency levels required.[151] Self-contained CRE equipment classes account for approximately 86 percent of industry shipments covered by this final rule. Incorporating variable-speed compressors into self-contained CRE designs would likely require additional development and testing time to optimize for different CRE applications to realize maximum efficiency benefits. Capital conversion costs may be necessary for new baseplate tooling if additional modifications are required to accommodate a larger compressor system.

CRE equipment classes with transparent doors (*i.e.*, HCT.SC.I, HCT.SC.L, HCT.SC.M, SOC.RC.M, SOC.SC.M, VCT.RC.L, VCT.RC.M, VCT.SC.H, VCT.SC.I, VCT.SC.L, and VCT.SC.M) account for approximately 41 percent of model listings. For the 84 OEMs that offer directly analyzed CRE with transparent doors, implementing vacuum-insulated glass would require significant engineering resources and testing time to ensure adequate durability of their doors in all commercial settings. Capital conversion costs may be necessary for new fixtures. In interviews and public comments, some manufacturers raised concerns about standards requiring a widespread adoption of vacuum-insulated glass as it is still a relatively new technology in the commercial refrigeration market. Manufacturers pointed to the very limited industry experience with implementing vacuum-insulated glass in CRE applications. Manufacturers expressed concerns about their ability to design and test a full portfolio of CRE with vacuum-insulated glass doors that meet the max-tech efficiencies and maintain their internal performance metrics for durability and safety over the equipment lifetime within the required compliance period (*i.e.*, between the

[151] DOE's Compliance Certification Database, "Refrigeration Equipment - Commercial, Single Compartment" is available at: *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A**. Model count estimates discussed throughout section V.B.2.a and section V.C of this document refer to unique basic models of the directly analyzed equipment classes only. (Last accessed Jan. 31, 2024).

publication of the final rule and the compliance date of the new and amended energy conservation standards). DOE estimates capital conversion costs of $30.6 million and product conversion costs of $223.5 million. Conversion costs total $254.1 million.

DOE acknowledges that most CRE manufacturers offer an exhaustive range of model offerings to appeal to the unique requirements of each CRE consumer. Within a model family, manufacturers offer numerous options to customize CRE to the specifications of restaurant, supermarket, and retail chains and other bulk purchasers of CRE (*e.g.*, Coca-Cola, Pepsi). In interviews, many manufacturers noted that offering a wide-range of models with a high-level of customization and optionality (*e.g.*, different evaporator setups, different lighting arrangements, different door configurations, *etc*.) is critical to succeed in the CRE market. Many manufacturers prioritize offering a breadth of model offerings and specialty CRE, even if sales of each individual model are low. As such, manufacturers still offer hundreds of basic models for equipment classes with low annual shipments. For example, SOC.RC.M accounts for approximately 5 percent of model listings (over 1,000 unique basic models certified in DOE's CCD) even though SOC.RC.M only accounts for 0.1 percent of industry shipments (less than 2,000 units sold in 2024). As discussed in section IV.J.2.c of this document, to avoid underestimating the potential industry investment, DOE's conversion cost model assumes manufacturers would redesign models that do not meet each considered TSL. However, if manufacturers do not have sufficient resources to redesign models within the compliance period, manufacturers would likely discontinue low-volume equipment designs and prioritize redesigning high-volume model offerings.

At TSL 5, the shipment-weighted average MPC for all CRE is expected to increase by 14.2 percent relative to the no-new-standards case shipment-weighted average MPC for all CRE in 2029. Given the projected increase in production costs, DOE expects an estimated 4.1-percent drop in shipments in the year the standard takes effect relative to the no-new-standards case. In the preservation-of-gross-margin-percentage scenario, the large increase in cash flow from the higher MSP outweighs the $254.1 million in conversion costs, causing a small increase in INPV at TSL 5 under this scenario. Under the preservation-of-operating-profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2029, the analyzed compliance year. This reduction in the manufacturer markup and the $254.1 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 5 under the preservation-of-operating-profit scenario. See section IV.J.2.d of this document for further details on the manufacturer markup scenarios.

At TSL 4, the standard represents an intermediate level with less stringent efficiencies required for 10 directly analyzed equipment classes compared to max-tech. The change in INPV is expected to range from -$160.1 million to -$63.5 million, which represents a change in INPV of -5.3 percent to -2.1 percent, respectively. At this level, free cash flow is estimated to decrease by 28.9 percent compared to the no-new-standards case value of $262.6 million in the year 2028, the year before compliance is required. In 2028, approximately 33.4 percent of covered CRE shipments are expected to meet the efficiencies required at TSL 4.

The design options DOE analyzed at TSL 4 are similar to the design options analyzed at TSL 5 except fewer equipment classes with transparent doors would need to incorporate improved door designs and fewer self-contained equipment classes would necessitate the use of variable-speed compressors. DOE estimates that a similar portion of models would require redesign at TSL 4 and TSL 5. DOE estimates that approximately 53 percent of analyzed equipment class model listings (10,574 out of a total of 19,902 unique basic models) do not meet the TSL 4 efficiency levels. Self-contained equipment classes that may incorporate variable-speed compressors represent approximately 90 percent of self-contained CRE model listings. For the five highest-volume equipment classes, TSL 4 corresponds to lower efficiency levels for 2 equipment classes: VCT.RC.M and VCT.SC.M. For VCS.SC.M, VCS.SC.L, and VCT.SC.L, the efficiencies required at TSL 4 are the same as TSL 5. For VCT.RC.M, TSL 4 corresponds to EL 3. For VCT.SC.M, TSL 4 corresponds to EL 4. At this level, DOE expects that VCT.RC.M and VCT.SC.M would incorporate triple-pane glass with krypton fill and argon fill, respectively. The 4 self-contained equipment classes with the highest-volume shipments (VCS.SC.L, VCS.SC.M, VCT.SC.L, and VCT.SC.M) would likely necessitate the use of variable-speed compressors.

Similar to TSL 5, DOE expects manufacturers would spend development time updating equipment designs to incorporate high-efficiency components. Manufacturers of CRE with transparent doors may need to invest in new fixtures to accommodate additional panes of glass into CRE designs. Unlike at TSL 5 where DOE expects all transparent door CRE equipment classes would incorporate vacuum-insulated glass doors to meet the efficiency levels required, only two directly analyzed equipment classes, SOC.SC.M and VCT.SC.L, (which represent approximately 9 percent of transparent door CRE model listings) would likely necessitate vacuum-insulated glass doors to meet at TSL 4. However, DOE expects that manufacturers of VCT.RC.L, VCT.RC.M, and SOC.RC.M (which represent approximately 63 percent of transparent door CRE model listings) would likely incorporate triple-pane glass doors with krypton fill and manufacturers of HCT.SC.I and VCT.SC.M (which represent approximately 25 percent of transparent door CRE model listings) would incorporate triple-pane glass doors with argon fill. As previously discussed, many manufacturers raised concerns about the widespread adoption of vacuum-insulated glass because the industry does not have widescale experience integrating this technology into their designs. In interviews and public comments, some manufacturers also raised concerns about the limited supply of krypton gas available to the market. Currently, few CRE designs have triple-pane glass doors with krypton fill as nearly all CRE with double-pane or triple-pane doors are manufactured with argon fill, and single-pane doors do not have an inert gas fill. DOE estimates capital conversion costs of $27.5 million and product conversion costs of $196.4 million. Conversion costs total $223.9 million.

As previously discussed with TSL 5, if manufacturers do not have sufficient resources to redesign models within the compliance period, manufacturers would likely discontinue low-volume equipment designs and prioritize redesigning high-volume model offerings.

At TSL 4, the shipment-weighted average MPC for all CRE is expected to increase by 4.8 percent relative to the no-new-standards case shipment-weighted average MPC for all CRE in 2029. Given the projected increase in production costs, DOE expects an estimated 1.8-percent drop in shipments in the year the standard takes effect relative to the no-new-standards case. In the preservation-of-gross-margin-percentage scenario, the increase in cash flow from the higher MSP is outweighed by the $223.9 million in conversion costs, causing a decrease in INPV at TSL 4 under this scenario. Under the preservation-of-operating-profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2029, the analyzed compliance year. This reduction in the manufacturer markup and the $223.9 million in conversion costs incurred by manufacturers cause a negative change in INPV at TSL 4 under the preservation-of-operating-profit scenario.

At TSL 3, the standard represents an intermediate level with less stringent efficiencies required for 12 directly analyzed equipment classes compared to TSL 4. The change in INPV is expected to range from -$78.7 million to -$51.3 million, which represents a change in INPV of -2.6 percent to -1.7 percent, respectively. At this level, free cash flow is estimated to decrease by 15.9 percent compared to the no-new-standards case value of $262.6 million in the year 2028, the year before compliance is required. In 2028, approximately 49.0 percent of covered CRE shipments are expected to meet the efficiencies required at TSL 3.

At TSL 3, the efficiency levels required for most open (*i.e.*, equipment classes without doors) and transparent door equipment classes are lower than the efficiency levels required at TSL 4. DOE estimates that notably fewer models would require redesign at TSL 3 compared to TSL 4 and TSL 5. At this level, approximately 37 percent of analyzed equipment class model listings (7,306 out of 19,902 unique basic models) do not meet the efficiency levels required. DOE expects manufacturers could meet TSL 3 without implementing occupancy sensors with dimming capability, triple-pane doors with krypton fill, or vacuum-insulated glass doors, alleviating industry concerns about the availability and supply of krypton gas and vacuum-insulated glass. At this level, the same equipment classes as TSL 4–except for VSC.SC.M, which represents 37 percent of self-contained CRE model listings–would likely incorporate variable-speed compressors. At this level, only 2 equipment classes, HCT.SC.I and SOC.SC.M (together representing 7 percent of transparent door CRE model listings), would likely incorporate improved door designs compared to 7 equipment classes that would likely incorporate improved door designs at TSL 4 (together representing 97 percent of transparent door CRE model listings). For the 5 highest-volume equipment classes, TSL 3 corresponds to lower efficiency levels for 4 equipment classes: VCS.SC.M, VCT.RC.M, VCT.SC.L, and VCT.SC.M. For VCS.SC.M, TSL 3 corresponds to EL 1. For VCT.RC.M, TSL 3 corresponds to baseline efficiency (*i.e.*, EL 0). For VCT.SC.L, TSL 3 corresponds to EL 2. For VCT.SC.M, TSL 3 corresponds to EL 2. For VCS.SC.L, the efficiencies required at TSL 3 are the same as TSL 4. At this level, product conversion costs may be necessary to source, qualify, and test high-efficiency components—but to a lesser extent than at higher TSLs. Some manufacturers of self-contained equipment classes may need to invest in new baseplate tooling if incorporating variable-speed compressors requires additional modifications to CRE designs. Manufacturers of CRE with transparent doors may need to invest in new fixtures to accommodate additional panes of glass into CRE designs. DOE estimates capital conversion costs of $19.1 million and product conversion costs of $98.5 million. Conversion costs total $117.7 million.

At TSL 3, the shipment-weighted average MPC for all CRE is expected to increase by 1.4 percent relative to the no-new-standards case shipment-weighted average MPC for all CRE in 2029. Given the relatively small projected increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation-of-gross-margin-percentage scenario, the increase in cash flow from the higher MSP is slightly outweighed by the $117.7 million in conversion costs, causing a small decrease in INPV at TSL 3 under this scenario. Under the preservation-of-operating-profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2029, the analyzed compliance year. This reduction in the manufacturer markup and the $117.7 million in conversion costs incurred by manufacturers cause a small negative change in INPV at TSL 3 under the preservation-of-operating-profit scenario.

At TSL 2, the standard represents an intermediate level with less stringent efficiencies required for 11 directly analyzed equipment classes compared to TSL 3. The change in INPV is expected to range from -$27.5 million to -$23.1 million, which represents a change in INPV of -0.9 percent to -0.8 percent, respectively. At this level, free cash flow is estimated to decrease by 6.0 percent compared to the no-new-standards case value of $262.6 million in the year 2028, the year before compliance is required. In 2028, approximately 60.7 percent of covered CRE shipments are expected to meet the efficiencies required at TSL 2.

At this level, the efficiency levels required are lower than TSL 3 for less than half of the directly analyzed equipment classes, which represent approximately 19 percent of industry shipments. DOE estimates that a similar portion of models would require redesign at TSL 2 and TSL 3. At this level, approximately 33 percent of analyzed equipment class model listings (6,631 out of 19,902 unique basic models) do not meet the efficiency levels required. DOE does not expect manufacturers would incorporate variable-speed compressors to meet efficiencies at TSL 2. At this level, DOE expects manufacturers would implement BLDC condenser fan motors for all self-contained equipment classes. Only HCT.SC.I would likely need to incorporate improved door designs. Open equipment classes would likely necessitate the use of night curtains. For the five highest-volume equipment classes, TSL 2 corresponds to lower efficiency levels for 3 equipment classes: VCS.SC.L, VCT.SC.L, and VCT.SC.M. For VCS.SC.L, TSL 2 corresponds to EL 2. For VCT.SC.L and VCT.SC.M, the TSL 2 corresponds to EL 1. For VSC.SC.M and VCT.RC.M, the efficiencies at TSL 2 are the same as TSL 3. At this level, DOE expects industry would incur minimal capital conversion costs. The lower efficiency levels required for 2 equipment classes—VCS.SC.L and VCT.SC.M—drive the drop in product conversion costs at this level. For VCS.SC.L and VCT.SC.M, DOE believes manufacturers could meet TSL 2 efficiencies by incorporating more efficient condenser fan motors with minimal development effort, unlike at TSL 3, which may necessitate implementing variable-speed compressors. DOE estimates capital conversion costs of $0.3 million and product conversion costs of $46.4 million. Conversion costs total $46.7 million.

At TSL 2, the shipment-weighted average MPC for all CRE is expected to increase by 0.2 percent relative to the no-new-standards case shipment-weighted average MPC for all CRE in 2029. Given the relatively small projected increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation-of-gross-margin-percentage scenario, the increase in cash flow from the higher MSP is slightly outweighed by the $46.7 million in conversion costs, causing a slight decrease in INPV at TSL 2 under this scenario. Under the preservation-of-operating-profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2028, the analyzed compliance year. This reduction in the manufacturer markup and the $46.7 million in conversion costs incurred by manufacturers cause a small negative change in INPV at TSL 2 under the preservation-of-operating-profit scenario.

At TSL 1, the standard represents the minimum efficiency level with positive LCC savings. The change in INPV is expected to range from -$24.7 million to -$20.8 million, which represents a change in INPV of -0.8 percent to -0.7 percent, respectively. At this level, free cash flow is estimated to decrease by 5.4 percent compared to the no-new-standards case value of $262.6 million in the year 2028, the year before compliance is required. In 2028, approximately 64.1 percent of covered CRE shipments are expected to meet the efficiencies required at TSL 1.

At this level, the efficiency levels correspond to baseline for 8 directly analyzed equipment classes, EL 1 for 19 equipment classes, and EL 2 for 1 equipment class (VCS.SC.H). DOE estimates that a similar portion of models would require redesign at TSL 1, TSL 2, and TSL 3. At this level, approximately 33 percent of analyzed equipment class model listings (6,504 out of 19,902 unique basic models) do not meet the efficiency levels required. DOE expects most self-contained equipment classes would need to incorporate higher-efficiency fan motors (*i.e.*, BLDC evaporator or condenser fan motors or PSC evaporator fan motors for chef bases). HCT.SC.I may necessitate the use of double-pane argon-fill doors to meet TSL 1 efficiencies. DOE expects manufacturers could TSL 1 efficiencies without investing in new tooling or equipment. Product conversion costs are driven by incorporating high-efficiency components into CRE designs. DOE estimates product conversion costs of $42.0 million.

At TSL 1, the shipment-weighted average MPC for all CRE is expected to increase by 0.2 percent relative to the no-new-standards case shipment-weighted average MPC for all CRE in 2029. Given the relatively small projected increase in production costs, DOE does not project a notable drop in shipments in the year the standard takes effect. In the preservation-of-gross-margin-percentage scenario, the minor increase in cash flow from the higher MSP slightly outweighs the $42.0 million in conversion costs, causing a minor increase in INPV at TSL 1 under this scenario. Under the preservation-of-operating-profit scenario, manufacturers earn the same per-unit operating profit as would be earned in the no-new-standards case, but manufacturers do not earn additional profit from their investments. In this scenario, the manufacturer markup decreases in 2029, the analyzed compliance year. This reduction in manufacturer markup and the $42.0 million in conversion costs incurred by manufacturers cause a minor negative change in INPV at TSL 1 under the preservation-of-operating-profit scenario.

Table V.65 Percentages of 2028 No-New-Standards Case Shipments that Meet Each TSL by Directly Analyzed Equipment Class

Equipment Family	Equipment Class	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Vertical Equipment	VOP.RC.M	63.5%	63.5%	63.5%	52.6%	52.6%
	VOP.RC.L	63.5%	63.5%	63.5%	52.6%	52.6%
	VOP.SC.M	10.1%	8.6%	4.9%	3.7%	3.7%
	VCT.RC.M	100.0%	100.0%	100.0%	51.6%	43.3%
	VCT.RC.L	100.0%	100.0%	100.0%	23.6%	14.6%
	VCT.SC.H	72.7%	59.1%	59.1%	59.1%	27.3%
	VCT.SC.M	57.4%	57.4%	41.8%	39.8%	38.8%
	VCT.SC.L	59.8%	59.8%	10.0%	9.9%	9.9%
	VCT.SC.I	100.0%	100.0%	100.0%	100.0%	51.9%
	VCS.SC.H	75.0%	75.0%	75.0%	75.0%	25.0%
	VCS.SC.M	55.4%	55.4%	55.4%	29.7%	29.7%
	VCS.SC.L	47.8%	47.6%	3.8%	3.8%	3.8%
	VCS.SC.I	92.1%	85.3%	32.5%	32.5%	32.5%
Semi-Vertical Equipment	SVO.RC.M	42.2%	42.2%	42.2%	30.6%	30.6%
	SVO.SC.M	48.9%	40.3%	32.2%	30.5%	30.5%
Service-Over-Counter Equipment	SOC.RC.M	100.0%	100.0%	100.0%	37.9%	37.2%
	SOC.SC.M	58.9%	56.0%	51.2%	44.3%	44.3%
Horizontal Equipment	HZO.RC.M	100.0%	100.0%	100.0%	100.0%	100.0%
	HZO.RC.L	100.0%	100.0%	100.0%	100.0%	100.0%
	HZO.SC.M	92.8%	92.8%	45.1%	45.1%	45.1%
	HZO.SC.L	92.8%	92.8%	45.1%	45.1%	45.1%
	HCT.SC.M	100.0%	100.0%	100.0%	100.0%	13.4%
	HCT.SC.L	100.0%	100.0%	100.0%	100.0%	39.8%
	HCT.SC.I	74.3%	71.0%	71.0%	71.0%	39.8%
	HCS.SC.M	76.5%	41.2%	41.2%	41.2%	41.2%
	HCS.SC.L	60.0%	60.0%	60.0%	60.0%	60.0%
Chef Bases	CB.SC.M	76.9%	76.9%	53.8%	53.8%	53.8%
	CB.SC.L	69.2%	53.8%	38.5%	38.5%	38.5%
Total		61.4%	60.7%	49.0%	33.4%	30.5%

b. Direct Impacts on Employment

To quantitatively assess the potential impacts of amended energy conservation standards on direct employment in the CRE industry, DOE used the GRIM to estimate the domestic labor expenditures and number of direct employees in the no-new-standards case and in each of the standards cases during the analysis period. DOE calculated these values using statistical data from the 2021 *ASM*,[152] BLS employee compensation data,[153] results of the engineering analysis, and manufacturer interviews.

Labor expenditures related to equipment manufacturing depend on the labor intensity of the equipment, the sales volume, and an assumption that wages remain fixed in real terms over time. The total labor expenditures in each year are calculated by multiplying the total MPCs by the labor percentage of MPCs. The total labor expenditures in the GRIM were then converted to total production employment levels by dividing production labor expenditures by the average fully burdened wage multiplied by the average number of hours worked per year per production worker. To do this, DOE relied on *ASM* inputs: Production Workers Annual Wages, Production Workers Annual Hours, Production Workers for Pay Period, and Number of Employees. DOE also relied on BLS employee compensation data to determine the fully burdened wage ratio. The fully burdened wage ratio factors in paid leave, supplemental pay, insurance, retirement and savings, and legally required benefits.

The total production employees number was then multiplied by the U.S. labor percentage to convert total production employment to total domestic production employment. The U.S. labor percentage represents the industry fraction of domestic manufacturing production capacity for the covered equipment. This value is derived from manufacturer

[152] U.S. Census Bureau, *Annual Survey of Manufactures*. "Summary Statistics for Industry Groups and Industries in the U.S (2021)." Available at *www.census.gov/data/tables/time-series/econ/asm/2018-2021-asm.html* (last accessed April 11, 2024).
[153] U.S. Bureau of Labor Statistics. *Employer Costs for Employee Compensation – March 2024*. June 18, 2024. Available at *www.bls.gov/bls/news-release/ecec.htm#current* (last accessed Aug. 22, 2024).

interviews, equipment database analysis, DOE's shipments analysis, and publicly available information. DOE estimates that approximately 77 percent of CRE covered by this final rule are produced domestically.

The domestic production employees estimate covers production line workers, including line supervisors, who are directly involved in fabricating and assembling equipment within the OEM facility. Workers performing services that are closely associated with production operations, such as materials handling tasks using forklifts, are also included as production labor.[154] DOE's estimates only account for production workers who manufacture the specific equipment covered by this final rule.

Non-production workers account for the remainder of the direct employment figure. The non-production employees category covers domestic workers who are not directly involved in the production process, such as sales, engineering, human resources, management, *etc*.[155] Using the number of domestic production workers calculated above, non-production domestic employees are extrapolated by multiplying the ratio of non-production workers in the industry compared to production employees. DOE assumes that this employee distribution ratio remains constant between the no-new-standards case and standards cases.

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[154] U.S. Census Bureau, "Definitions and Instructions for the Annual Survey of Manufactures, MA-10000." Available at *www2.census.gov/programs-surveys/asm/technical-documentation/questionnaire/2021/instructions/MA_10000_Instructions.pdf* (last accessed April 11, 2024).
[155] *Id.*

Using the GRIM, DOE estimates that in the absence of new energy conservation standards, there would be 11,792 domestic production and non-production workers for CRE in 2029. shows the range of impacts of energy conservation standards on U.S. manufacturing employment in the CRE industry. The discussion below provides a qualitative evaluation of the range of potential impacts presented in Table V.66.

Table V.66 Direct Employment Impacts for Domestic CRE Manufacturers in 2029*

	No-New-Standards Case	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Direct Employment in 2029 (Production Workers + Non-Production Workers)	11,792	11,785 to 11,792	8,391 to 11,783	7,388 to 11,699	6,028 to 11,616	5,778 to 11,642
Potential Changes in Direct Employment in 2029	-	(7) to 0	(3,401) to (9)	(4,404) to (93)	(5,764) to (176)	(6,014) to (150)

*DOE presents a range of potential employee impacts. Numbers in parentheses indicate negative numbers.

The direct employment impacts in represent the potential domestic employment changes that could result following the compliance date for CRE in this final rule. The upper bound estimate corresponds to a potential change in the number of domestic workers that would result from new and amended energy conservation standards if manufacturers continue to produce the same scope of covered equipment within the United States after compliance takes effect. For the lower bound estimate, DOE maintained its methodology from the August 2024 NODA for this final rule. 89 FR 68788, 68828-68829.

The lower bound estimate conservatively assumes that some domestic manufacturing either is eliminated or moves abroad at more stringent efficiency levels. For levels that require capital investment or higher per-unit labor content, DOE assumed that some manufacturing could move abroad as relocating production to lower-labor cost countries could become increasingly attractive. At relevant TSLs, DOE used results of the shipments analysis (*i.e.*, the percent of shipments that would not meet the standard) to estimate the portion of domestic production that would shift to foreign countries. However, DOE notes that most of the design options analyzed in the engineering analysis require manufacturers to purchase more-efficient components from suppliers. These components do not require significant additional labor to assemble or significant production line updates. As in the August 2024 NODA, for this final rule, DOE modeled an incremental increase in labor costs associated with implementing improved door designs (*i.e.*, moving to double-pane, triple-pane, or VIG door designs). Incorporating vacuum-insulated panels could lead to greater labor requirements; however, as discussed in section IV.B.1 of this document, DOE did not consider vacuum-insulated panels as a design option in its engineering analysis. At the adopted TSL (*i.e.*, TSL 3), DOE projects that nearly half of industry shipments will meet the required efficiency levels by the 2029 compliance date in the no-new-standards case. Additionally, DOE notes that only two directly analyzed equipment classes would likely incorporate improved door designs. As such, DOE does not expect TSL 3 will necessitate large capital costs or significantly higher per-unit labor content. Furthermore, DOE notes that most basic models (63 percent of model listings) meet TSL 3.

Additional detail on the analysis of direct employment can be found in chapter 12 of the final rule TSD. Additionally, the employment impacts discussed in this section are independent of the employment impacts from the broader U.S. economy, which are documented in chapter 16 of the final rule TSD.

c. Impacts on Manufacturing Capacity

In interviews conducted in advance of the October 2023 NOPR, most manufacturers noted potential manufacturing capacity concerns relating to widespread adoption of increased insulation thickness or VIPs. As discussed in section IV.B.1 of this document, DOE excluded these technologies from further consideration in the engineering analysis and, thus, DOE does not expect manufacturers would need to increase insulation thickness or incorporate VIPs to meet any of the efficiency levels analyzed in this final rule. Furthermore, DOE revised its baseline insulation thickness assumptions used in the October 2023 NOPR in response to stakeholder comments. The revised insulation thicknesses analyzed in the August 2024 NODA and this final rule generally align with the insulation thicknesses analyzed in the March 2014 Final Rule,[156] which are also consistent with stakeholder comments and DOE's test data.

Therefore, when considering potential new and amended energy conservation standards in isolation, DOE believes manufacturers would be able to maintain manufacturing capacity levels and continue to meet market demand under new and amended energy conservation standards. However, multiple manufacturers in confidential interviews and public comments in response to the October 2023 NOPR and August 2024 NODA raised concerns about technical and laboratory resource constraints due to overlapping regulations over a short time period. Specifically, these manufacturers mentioned the testing and redesign required for new safety and industry standards and the various regulations

[156] DOE assumed an insulation thickness of 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. See Table 5A.2.2 Baseline Specifications in the 2014 Final rule TSD at *www.regulations.gov/document/EERE-2010-BT-STD-0003-0102.*

necessitating the transition to low-GWP refrigerants. In confidential interviews and comments in response to the October 2023 NOPR and August 2024 NODA, some manufacturers stated that they are already experiencing testing laboratory shortages, which would be further exacerbated by DOE energy conservation standards if DOE adopts more stringent standards that necessitate the redesign of the majority of basic models. Manufacturers noted that the ongoing supply chain constraints further strain technical and laboratory resources as manufacturers are forced to identify and qualify new component suppliers due to shortages and long lead times.

At the adopted TSL (*i.e.*, TSL 3), DOE estimates that approximately 63 percent of analyzed equipment class model listings (12,596 out of 19,902 unique basic models) meet the efficiency levels required. Furthermore, DOE is extending the compliance period from the 3-years analyzed in the October 2023 NOPR to 4-years in this final rule to help mitigate concerns about laboratory and engineering resource constraints.

d. Impacts on Subgroups of Manufacturers

Small business, low volume, and niche equipment manufacturers, and manufacturers exhibiting a cost structure substantially different from the industry average, could be affected disproportionately. As discussed in section IV.J of this document, using average cost assumptions to develop an industry cash flow estimate is inadequate to assess differential impacts among manufacturer subgroups.

For CRE, DOE identified and evaluated the impact of new and amended conservation standards on one subgroup: small manufacturers. The Small Business Administration

(“SBA”) defines a “small business” as having 1,250 employees or fewer for NAICS 333415, “Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing,” which includes CRE manufacturing. Based on this definition, DOE identified 20 domestic OEMs in the CRE industry that qualify as a “small business.”

For a discussion of the impacts on the small manufacturer subgroup, see the regulatory flexibility analysis in section VI.B of this document or chapter 12 of the final rule TSD.

e. Cumulative Regulatory Burden

One aspect of assessing manufacturer burden involves looking at the cumulative impact of multiple DOE standards and the equipment/product-specific regulatory actions of other Federal agencies and States that affect the manufacturers of a covered product or equipment. While any one regulation may not impose a significant burden on manufacturers, the combined effects of several existing or impending regulations may have serious consequences for some manufacturers, groups of manufacturers, or an entire industry. Assessing the impact of a single regulation may overlook this cumulative regulatory burden. In addition to energy conservation standards, other regulations can significantly affect manufacturers’ financial operations. Multiple regulations affecting the same manufacturer can strain profits and lead companies to abandon product lines or markets with lower expected future returns than competing equipment. For these reasons, DOE conducts an analysis of cumulative regulatory burden as part of its rulemakings pertaining to appliance efficiency. DOE evaluates equipment/product-specific regulations that will take effect approximately 3 years before or after the estimated 2029 compliance date of any new and amended energy conservation standards for CRE (2026–2032).

The DOE energy conservation standards regulations potentially contributing to cumulative regulatory burden are presented in Table V.67. In addition to the proposed and adopted energy conservation standards rulemakings identified, DOE also considers refrigerant regulations, such as the October 2023 EPA Final Rule, in its cumulative regulatory burden analysis. DOE discusses these refrigerant regulations in the subsection "Refrigerant Regulations" included in this section.

Table V.67 Compliance Dates and Expected Conversion Expenses of Federal Energy Conservation Standards Affecting Commercial Refrigeration Equipment OEMs

Federal Energy Conservation Standard	Number of OEMs*	Number of OEMs Affected by Today's Rule**	Approx. Standards Compliance Year	Industry Conversion Costs *(Millions)*	Industry Conversion Costs / Equipment Revenue***
Automatic Commercial Ice Makers† 88 FR 30508 (May 11, 2023)	23	7	2027	$15.9 (2022$)	0.6%
Refrigerated Bottled or Canned Beverage Vending Machines† 88 FR 33968 (May 25, 2023)	5	1	2028	$1.5 (2022$)	0.2%
Room Air Conditioners 88 FR 34298 (May 26, 2023)	8	1	2026	$24.8 (2021$)	0.4%
Microwave Ovens 88 FR 39912 (June 20, 2023)	18	3	2026	$46.1 (2021$)	0.7%
Dehumidifiers† 88 FR 76510 (November 6, 2023)	20	2	2028	$6.9 (2022$)	0.4%
Consumer Furnaces 88 FR 87502 (December 18, 2023)	14	2	2028	$162.0 (2022$)	1.8%
Refrigerators, Refrigerator-Freezers, and Freezers 89 FR 3026	63	10	2029 and 2030‡	$830.3 (2022$)	1.3%

(January 17, 2024)					
Consumer Conventional Cooking Products 89 FR 11548 (February 14, 2024)	35	4	2028	$66.7 (2022$)	0.3%
Consumer Clothes Dryers 89 FR 18164 (March 12, 2024)	19	3	2028	$180.7 (2022$)	1.4%
Residential Clothes Washers 89 FR 19026 (March 15, 2024)	22	4	2028	$320.0 (2022$)	1.8%
Dishwashers 89 FR 31398 (April 24, 2024)	21	4	2027	$126.9 (2022$)	2.1%
Miscellaneous Refrigeration Products 89 FR 38762 (May 7, 2024)	49	13	2029	$130.7 (2022$)	2.9%
Walk-in Coolers and Freezers††	87	11	2028	$91.5 (2023$)	0.6%

* This column presents the total number of OEMs identified in the energy conservation standard rule that is contributing to cumulative regulatory burden.
** This column presents the number of OEMs producing CRE that are also listed as OEMs in the identified energy conservation standard that is contributing to cumulative regulatory burden.
*** This column presents industry conversion costs as a percentage of equipment revenue during the conversion period. Industry conversion costs are the upfront investments manufacturers must make to sell compliant products/equipment. The revenue used for this calculation is the revenue from just the covered product/equipment associated with each row. The conversion period is the time frame over which conversion costs are made and lasts from the publication year of a final rule to the compliance year of the energy conservation standard. The conversion period typically ranges from 3 to 5 years, depending on the rulemaking.
† These rulemakings are at the NOPR stage, and all values are subject to change until finalized through publication of a final rule.
‡ For the refrigerators, refrigerator-freezers, and freezers energy conservation standards direct final rule, the compliance year (2029 or 2030) varies by product class.
†† At the time of issuance of this final rule, the WICFs final rule has been issued and is pending publication in the *Federal Register*. Once published, the final rule pertaining to WICFs will be available at: *www.regulations.gov/docket/EERE-2017-BT-STD-0009.*

Refrigerant Regulations

The October 2023 EPA Final Rule restricts the use of HFCs in specific sectors or subsectors, including use in certain CRE covered by this rulemaking. Consistent with the October 2023 NOPR, DOE considered the impacts of the refrigerant transition in this final rule analysis. DOE understands that switching from non-flammable to flammable refrigerants (*e.g.*, R-290) requires time and investment to redesign CRE models and upgrade production facilities to accommodate the additional structural and safety precautions required. Compliance with the October 2023 EPA Final Rule ranges from January 1, 2025 to January 1, 2027 for categories relevant to CRE covered by this rulemaking (see Table IV.5 for a list of compliance dates for the October 2023 EPA Final Rule applicable to CRE). Therefore, DOE expects manufacturers will complete the transition to low-GWP refrigerants in compliance with EPA regulation prior to the expected 2029 DOE compliance date for CRE. As discussed in section IV.C.1.a of this document, DOE expects CRE manufacturers will transition self-contained CRE covered by this rulemaking to R-290 to comply with anticipated refrigeration regulations. See section IV.C.1 of this document for additional information on refrigerant assumptions in the engineering analysis.

Consistent with the October 2023 NOPR and August 2024 NODA, in this final rule, DOE accounted for the costs associated with redesigning CRE to make use of flammable refrigerants and retrofitting production facilities to accommodate flammable refrigerants in the GRIM. DOE considers the expenses associated with the refrigerant transition as part of the analytical baseline. In other words, manufacturers would need to comply with the October 2023 EPA Final Rule regardless of whether or not DOE amends standards. Therefore, DOE incorporated the refrigerant transition expenses into both the no-new-standards case and standards cases. For the October 2023 NOPR, DOE relied on manufacturer feedback in confidential interviews, a report prepared for EPA,[157] results of the

[157] See pp. 5–113 of the "Global Non-CO_2 Greenhouse Gas Emission Projections & Marginal Abatement Cost Analysis: Methodology Documentation" (2019). Available at *www.epa.gov/sites/default/files/2019-09/documents/nonco2_methodology_report.pdf*.

engineering analysis, and investment estimates submitted by NAMA and AHRI in response to the June 2022 Preliminary Analysis to estimate the industry refrigerant transition costs. 88 FR 70196, 70284. For the August 2024 NODA, DOE updated its R&D estimate to reflect feedback from written comments in response to the October 2023 NOPR. 89 FR 68788, 68800. DOE also adjusted the timeline of when manufacturers would need to make investments related to the refrigerant transition to align with the revised compliance dates for CRE in the October 2023 EPA Final Rule. *Id*. DOE maintained the approach from the August 2024 NODA for this final rule, however, as this final rule only analyzes non-large self-contained CRE (see Table IV. for the TDA/volume ranges for the seven relevant equipment classes) and remote-condensing CRE, DOE excluded the investments associated with large self-contained CRE in its GRIM.

Based on feedback, DOE assumed that the transition to low-GWP refrigerants would require industry to invest approximately $13.6 million in R&D and $17.7 million in capital expenditures (*e.g.*, investments in new charging equipment, leak detection systems, *etc.*) from 2024 (the final rule reference year) and 2027 (the latest EPA compliance date for CRE covered by this rulemaking). Consistent with the October 2023 NOPR, DOE notes that its refrigerant transition estimates of $13.6 million in R&D and $17.7 million capital expenditures reflect an estimate of *future* (2023-2025 for the October 2023 NOPR and 2024-2027 for this final rule) investments industry would incur to comply with Federal or State refrigerant regulations. DOE acknowledges that manufacturers have already invested a significant amount of time and capital into transitioning CRE to low-GWP refrigerants. However, as the GRIM developed for this rulemaking only analyzes future cash flows, starting with the reference year of the analysis (2024) and continuing 30 years after the analyzed compliance year, the MIA conducted for this final rule only reflects changes in annual cash flow and associated refrigerant transition expenses starting in 2024.

3. National Impact Analysis

This section presents DOE's estimates of the NES and the NPV of consumer benefits that would result from each of the TSLs considered as potential amended standards.

a. National Energy Savings

To estimate the energy savings attributable to potential new and amended standards for CRE, DOE compared their energy consumption under the no-new-standards case to their anticipated energy consumption under each TSL. The savings are measured over the entire lifetime of equipment purchased during the 30-year period that begins in the year of anticipated compliance with new and amended standards (2029–2058). Table V. presents DOE's projections of the NES for each TSL considered for CRE. The savings were calculated using the approach described in section IV.H.2 of this document.

Table V.68 Cumulative National Energy Savings for CRE; 30 Years of Shipments (2029–2058)

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
	quads				
Primary energy	0.24	0.28	1.08	1.46	1.57
FFC energy	0.25	0.29	1.11	1.50	1.61

OMB Circular A-4[158] requires agencies to present analytical results, including separate schedules of the monetized benefits and costs that show the type and timing of benefits and costs. Circular A-4 also directs agencies to consider the variability of key elements underlying the estimates of benefits and costs. For this rulemaking, DOE undertook a sensitivity analysis using 9 years, rather than 30 years, of equipment shipments. The choice of a 9-year period is a proxy for the timeline in EPCA for the review of certain energy conservation standards and potential revision of and compliance with such revised standards.[159] The review timeframe established in EPCA is generally not synchronized with the equipment lifetime, equipment manufacturing cycles, or other factors specific to CRE. Thus, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology. The NES sensitivity analysis results based on a 9-year analytical period are presented in Table V.. The impacts are counted over the lifetime of CRE purchased during the period 2029–2037.

Table V.69 Cumulative National Energy Savings for CRE; 9 Years of Shipments (2029–2037)

	Trial Standard Level				
	1	2	3	4	5
	quads				
Primary energy	0.07	0.08	0.31	0.41	0.44
FFC energy	0.07	0.08	0.32	0.43	0.45

[158] U.S. Office of Management and Budget. *Circular A-4: Regulatory Analysis*. Available at *www.whitehouse.gov/omb/information-for-agencies/circulars* (last accessed July 1, 2024). DOE used the prior version of Circular A-4 (September 17, 2003) in accordance with the effective date of the November 9, 2023 version. Available at *www.whitehouse.gov/wp-content/uploads/legacy_drupal_files/omb/circulars/A4/a-4.pdf* (last accessed July 20, 2024).

[159] EPCA requires DOE to review its standards at least once every 6 years, and requires, for certain products, a 3-year period after any new standard is promulgated before compliance is required, except that in no case may any new standards be required within 6 years of the compliance date of the previous standards. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(m)) While adding a 6-year review to the 3-year compliance period adds up to 9 years, DOE notes that it may undertake reviews at any time within the 6-year period and that the 3-year compliance date may yield to the 6-year backstop. A 9-year analysis period may not be appropriate given the variability that occurs in the timing of standards reviews and the fact that for some products, the compliance period is 5 years rather than 3 years.

b. Net Present Value of Consumer Costs and Benefits

DOE estimated the cumulative NPV of the total costs and savings for consumers that would result from the TSLs considered for CRE. In accordance with OMB Circular A-4, DOE calculated NPV using both a 7-percent and a 3-percent real discount rate. Table V. shows the consumer NPV results with impacts counted over the lifetime of equipment purchased during the period 2029–2058.

Table V.70 Cumulative Net Present Value of Consumer Benefits for CRE; 30 Years of Shipments (2029–2058)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	billion 2023$				
3 percent	0.60	0.74	3.43	1.89	-8.45
7 percent	0.24	0.29	1.32	0.22	-5.36

The NPV results based on the aforementioned 9-year analytical period are presented in Table V.71. The impacts are counted over the lifetime of equipment purchased during the period 2029–2058. As mentioned previously, such results are presented for informational purposes only and are not indicative of any change in DOE's analytical methodology or decision criteria.

Table V.71 Cumulative Net Present Value of Consumer Benefits for CRE; 9 Years of Shipments (2029–2037)

Discount Rate	Trial Standard Level				
	1	2	3	4	5
	billion 2023$				
3 percent	0.23	0.29	1.22	0.57	-3.33
7 percent	0.12	0.15	0.62	0.03	-2.80

The previous results reflect the use of a default trend to estimate the change in price for CRE over the analysis period (see section IV.F.1 of this document). DOE also conducted a sensitivity analysis where CRE prices were assumed to remain constant over the analysis period. This analysis was considered as a part of the low economic benefits scenario, which is based on low economic growth with lower electricity price declines and lower floorspace projections for shipments. See Appendix 10C of the final rule TSD for full results of all NIA sensitivities conducted.

c. Indirect Impacts on Employment

DOE estimates that amended energy conservation standards for CRE will reduce energy expenditures for consumers of those equipment, with the resulting net savings being redirected to other forms of economic activity. These expected shifts in spending and economic activity could affect the demand for labor. As described in section IV.N of this document, DOE used an input/output model of the U.S. economy to estimate indirect employment impacts of the TSLs that DOE considered. There are uncertainties involved in projecting employment impacts, especially changes in the later years of the analysis. Therefore, DOE generated results for near-term timeframes (2029–2033), where these uncertainties are reduced.

The results suggest that the adopted standards are likely to have a negligible impact on the net demand for labor in the economy. The net change in jobs is so small that it would be imperceptible in national labor statistics and might be offset by other, unanticipated effects on employment. Chapter 16 of the final rule TSD presents detailed results regarding anticipated indirect employment impacts.

4. Impact on Utility or Performance of Equipment

As discussed in section III.F.1.d of this document, DOE has concluded that the standards adopted in this final rule will not lessen the utility or performance of the CRE under consideration in this rulemaking. Manufacturers of this equipment generally already offer units that meet or exceed the adopted standards.

5. Impact of Any Lessening of Competition

DOE considered any lessening of competition that would be likely to result from new or amended standards. As discussed in section III.F.1.e of this document, EPCA directs the Attorney General of the United States ("Attorney General") to determine the impact, if any, of any lessening of competition likely to result from a proposed standard and to transmit such determination in writing 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. To assist the Attorney General in making this determination, DOE provided the Department of Justice ("DOJ") with copies of the October 2023 NOPR and the October 2023 NOPR TSD for review. 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.

6. Need of the Nation to Conserve Energy

Enhanced energy efficiency, where economically justified, improves the Nation's energy security, strengthens the economy, and reduces the environmental impacts (costs) of energy production. Reduced electricity demand due to energy conservation standards is also likely to reduce the cost of maintaining the reliability of the electricity system, particularly during peak-load periods. Chapter 15 of the final rule TSD presents the estimated impacts on electricity-generating capacity, relative to the no-new-standards case, for the TSLs that DOE considered in this rulemaking.

Energy conservation resulting from potential energy conservation standards for CRE is expected to yield environmental benefits in the form of reduced emissions of certain air pollutants and GHGs. Table V. provides DOE's estimate of cumulative emissions reduction expected to result from the TSLs considered in this rulemaking. The emissions were calculated using the multipliers discussed in section IV.K of this document. DOE reports annual emissions reductions for each TSL in chapter 13 of the final rule TSD.

Table V.72 Cumulative Emissions Reduction for CRE Shipped During the Period 2029–2058

	Trial Standard Level				
	1	**2**	**3**	**4**	**5**
Electric Power Sector Emission					
CO_2 (*million metric tons*)	3.99	4.61	17.9	24.2	25.9
CH_4 (*thousand tons*)	0.29	0.34	1.32	1.78	1.91
N_2O (*thousand tons*)	0.04	0.05	0.18	0.25	0.26
SO_2 (*thousand tons*)	1.86	2.15	8.35	11.3	12.1
NO_X (*thousand tons*)	1.32	1.52	5.91	7.99	8.55
Hg (*tons*)	0.01	0.01	0.04	0.06	0.06
Upstream Emissions					
CO_2 (*million metric tons*)	0.41	0.47	1.83	2.48	2.66
CH_4 (*thousand tons*)	37.1	43.0	167	226	242
N_2O (*thousand tons*)	0.00	0.00	0.01	0.01	0.01
SO_2 (*thousand tons*)	6.37	7.37	28.6	38.7	41.4
NO_X (*thousand tons*)	0.02	0.03	0.11	0.15	0.16
Hg (*tons*)	0.00	0.00	0.00	0.00	0.00
Total FFC Emissions					
CO_2 (*million metric tons*)	4.39	5.09	19.7	26.7	28.6
CH_4 (*thousand tons*)	37.4	43.3	168	228	243
N_2O (*thousand tons*)	0.04	0.05	0.19	0.26	0.28
SO_2 (*thousand tons*)	8.23	9.52	36.9	50.0	53.5
NO_X (*thousand tons*)	1.34	1.55	6.02	8.14	8.71
Hg (*tons*)	0.01	0.01	0.04	0.06	0.06

* 0.00 indicates values less than 0.005

As part of the analysis for this rule, DOE estimated monetary benefits likely to result from the reduced emissions of CO_2 that DOE estimated for each of the considered TSLs for CRE. Section IV.L of this document discusses the two separate sets of estimated SC-CO_2 values that DOE used. Table V.73 and Table V.74 presents the value of CO_2 emissions reductions at each TSL for each of the SC-CO_2 cases. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V.73 Present Value of CO_2 Emissions Reduction for CRE Shipped During the Period 2029–2058 (2023 SC-GHG Estimates)

TSL	SC-CO_2 Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.54	0.93	1.65
2	0.63	1.07	1.91
3	2.43	4.16	7.42
4	3.29	5.63	10.04
5	3.52	6.02	10.7

Table V.74 Present Value of CO_2 Emissions Reduction for CRE Shipped During the Period 2029–2058 (2021 Interim SC-GHG Estimates)

TSL	SC-CO_2 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2023$			
1	0.05	0.20	0.30	0.59
2	0.05	0.23	0.35	0.69
3	0.21	0.88	1.37	2.66
4	0.28	1.18	1.85	3.59
5	0.30	1.27	1.98	3.84

As discussed in section IV.L.2 of this document, DOE estimated the climate benefits likely to result from the reduced emissions of methane and N_2O that DOE estimated for each of the considered TSLs for CRE. Table V.75 and Table V.76 presents the value of the CH_4 emissions reduction at each TSL for each of the SC-CH_4 cases. Table V. and Table V.78 presents the value of the N_2O emissions reduction at each TSL for each of the SC-N_2O cases. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V.75 Present Value of Methane Emissions Reduction for CRE Shipped During the Period 2029–2058 (2023 SC-GHG Estimates)

TSL	SC-CH_4 Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.07	0.10	0.14
2	0.08	0.11	0.16
3	0.32	0.43	0.62
4	0.43	0.59	0.84
5	0.46	0.63	0.90

Table V.76 Present Value of Methane Emissions Reduction for CRE Shipped During the Period 2029–2058 (2021 Interim SC-GHG Estimates)

TSL	SC-CH_4 Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2023$			
1	0.02	0.05	0.07	0.14
2	0.02	0.06	0.09	0.16
3	0.08	0.24	0.33	0.63
4	0.11	0.32	0.45	0.86
5	0.12	0.35	0.48	0.92

Table V.77 Present Value of Nitrous Oxide Emissions Reduction for CRE Shipped During the Period 2029–2058 (2023 SC-GHG Estimates)

TSL	SC-N_2O Case		
	Near-term Ramsey Discount Rate		
	2.5%	2.0%	1.5%
	billion 2023$		
1	0.002	0.002	0.004
2	0.002	0.003	0.005
3	0.01	0.01	0.02
4	0.01	0.01	0.02
5	0.01	0.02	0.03

Table V.78 Present Value of Nitrous Oxide Emissions Reduction for CRE Shipped During the Period 2029–2058 (2021 Interim SC-GHG Estimates)

TSL	SC-N_2O Case			
	Discount Rate and Statistics			
	5%	3%	2.5%	3%
	Average	Average	Average	95th percentile
	billion 2023$			
1	0.0002	0.001	0.001	0.002
2	0.000	0.001	0.001	0.002
3	0.001	0.003	0.00	0.01
4	0.001	0.004	0.01	0.01
5	0.001	0.004	0.01	0.01

DOE is well aware that scientific and economic knowledge about the contribution of CO_2 and other GHG emissions to changes in the future global climate and the potential resulting damages to the global and U.S. economy continues to evolve rapidly. DOE, together with other Federal agencies, will continue to review methodologies for estimating the monetary value of reductions in CO_2 and other GHG emissions. This ongoing review will consider the comments on this subject that are part of the public record for this and other rulemakings, as well as other methodological assumptions and issues. DOE notes, however, that the adopted standards would be economically justified even without inclusion of monetized benefits of reduced GHG emissions.

DOE also estimated the monetary value of the economic benefits associated with NO_X and SO_2 emissions reductions anticipated to result from the considered TSLs for CRE. The dollar-per-ton values that DOE used are discussed in section IV.L of this document. Table V.79 presents the present value for NO_X emissions reduction for each TSL calculated using 7-percent and 3-percent discount rates, and Table V.80 presents similar results for SO_2 emissions reductions. The results in these tables reflect application of EPA's low dollar-per-ton values, which DOE used to be conservative. The time-series of annual values is presented for the selected TSL in chapter 14 of the final rule TSD.

Table V.79 Present Value of NO_X Emissions Reduction for CRE Shipped During the Period 2029–2058

TSL	3% Discount Rate	7% Discount Rate
	million 2023$	
1	398	155
2	460	179
3	1,785	695
4	2,414	939
5	2,582	1,004

Table V.80 Present Value of SO_2 Emissions Reduction for CRE Shipped During the Period 2029–2058

TSL	3% Discount Rate	7% Discount Rate
	million 2023$	
1	91	36
2	105	42
3	408	161
4	551	218
5	590	232

Not all the public health and environmental benefits from the reduction of GHG, NO_X, and SO_2 are captured in the values above, and additional unquantified benefits from the reductions of those pollutants as well as from the reduction of direct PM and other co-pollutants may be significant. DOE has not included monetary benefits of the reduction of Hg emissions because the amount of reduction is very small.

7. Other Factors

The Secretary, in determining whether a standard is economically justified, may consider any other factors that the Secretary deems to be relevant. (42 U.S.C. 6295(o)(2)(B)(i)(VII), 42 U.S.C. 6316(e)(1)) No other factors were considered in this analysis.

8. Summary of Economic Impacts

Table V.81 and Table V.82 presents the NPV values that result from adding the estimates of the economic benefits resulting from reduced GHG and NO_X and SO_2 emissions to the NPV of consumer benefits calculated for each TSL considered in this rulemaking. The consumer benefits are domestic U.S. monetary savings that occur as a result of purchasing the covered equipment and are measured for the lifetime of equipment shipped during the period 2029-2058. The climate benefits associated with reduced GHG emissions resulting from the adopted standards are global benefits and are also calculated based on the lifetime of CRE shipped during the period 2029-2058.

Table V.81 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits (2023 SC-GHG Estimates)

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5

Using 3% discount rate for Consumer NPV and Health Benefits (billion 2023$)					
2.5% Near-term Ramsey DR	1.71	2.02	8.38	8.58	-1.28
2.0% Near-term Ramsey DR	2.12	2.50	10.2	11.1	1.39
1.5% Near-term Ramsey DR	2.89	3.39	13.7	15.7	6.38
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2023$)					
2.5% Near-term Ramsey DR	1.04	1.22	4.93	5.11	-0.14
2.0% Near-term Ramsey DR	1.45	1.70	6.78	7.61	2.54
1.5% Near-term Ramsey DR	2.22	2.59	10.2	12.3	7.53

Table V.82 Consumer NPV Combined with Present Value of Climate Benefits and Health Benefits (2021 Interim SC-GHG Estimates)

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Using 3% discount rate for Consumer NPV and Health Benefits (billion 2023$)					
5% Average SC-GHG case	1.2	1.4	5.9	5.2	-4.9
3% Average SC-GHG case	1.3	1.6	6.7	6.4	-3.7
2.5% Average SC-GHG case	1.5	1.7	7.3	7.2	-2.8
3% 95th percentile SC-GHG case	1.8	2.2	8.9	9.3	-0.5
Using 7% discount rate for Consumer NPV and Health Benefits (billion 2023$)					
5% Average SC-GHG case	0.5	0.6	2.5	1.8	-3.7
3% Average SC-GHG case	0.7	0.8	3.3	2.9	-2.5
2.5% Average SC-GHG case	0.8	1.0	3.9	3.7	-1.7
3% 95th percentile SC-GHG case	1.2	1.4	5.5	5.8	0.6

C. Conclusion

When considering new or amended energy conservation standards, the standards 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)) In determining whether a standard is economically justified, the Secretary must determine whether the benefits of the standard exceed its burdens by, to the greatest extent practicable, considering the seven statutory factors discussed previously. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(2)(B)(i))) The new or amended standard must also result in significant conservation of energy. (42 U.S.C. 6316(e)(1); 42 U.S.C. 6295(o)(3)(B)(i))

For this final rule, DOE considered the impacts of new and amended standards for CRE at each TSL, beginning with the maximum technologically feasible level, to determine whether that level was economically justified. Where the max-tech level was not justified, DOE then considered the next most efficient level and undertook the same evaluation until it reached the highest efficiency level that is both technologically feasible and economically justified and saves a significant amount of energy.

To aid the reader as DOE discusses the benefits and/or burdens of each TSL, tables in this section present a summary of the results of DOE's quantitative analysis for each TSL. In addition to the quantitative results presented in the tables, DOE also considers other burdens and benefits that affect economic justification. These include the impacts on identifiable subgroups of consumers who may be disproportionately affected by a national standard and impacts on employment.

DOE also notes that the economics literature provides a wide-ranging discussion of how consumers trade off upfront costs and energy savings in the absence of government intervention. Much of this literature attempts to explain why consumers appear to undervalue energy efficiency improvements. There is evidence that consumers undervalue future energy savings as a result of (1) a lack of information; (2) a lack of sufficient salience of the long-term or aggregate benefits; (3) a lack of sufficient savings to warrant delaying or altering purchases; (4) excessive focus on the short term, in the form of inconsistent weighting of future energy cost savings relative to available returns on other investments; (5) computational or other difficulties associated with the evaluation of relevant tradeoffs; and (6) a divergence in incentives (for example, between business owners and renters). Having less than perfect foresight and a high degree of uncertainty about the future, consumers may trade off these types of investments at a higher-than-expected rate between current consumption and uncertain future energy cost savings.

In DOE's current regulatory analysis, potential changes in the benefits and costs of a regulation due to changes in consumer purchase decisions are included in two ways. First, if consumers forgo the purchase of CRE in the standards case, this decreases sales for manufacturers, and the impact on manufacturers attributed to lost revenue is included in the MIA. Second, DOE accounts for energy savings attributable only to equipment actually used by consumers in the standards case; if a standard decreases the number of equipment purchased by consumers, this decreases the potential energy savings from an energy conservation standard. DOE provides estimates of shipments and changes in the volume of CRE purchases in chapter 9 of the final rule TSD.

1. Benefits and Burdens of TSLs Considered for CRE Standards

Table V.83 and Table V.84 summarize the quantitative impacts estimated for each TSL for CRE. The national impacts are measured over the lifetime of CRE purchased during the 30-year period that begins in the anticipated year of compliance with amended standards (2029–2058). The energy savings, emissions reductions, and value of emissions reductions refer to full-fuel-cycle results. DOE is presenting monetized benefits of GHG emissions reductions in accordance with the applicable Executive orders, and DOE would reach the same conclusion presented in this notice in the absence of the SC-GHG, including the 2023 SC-GHG. The efficiency levels contained in each TSL are described in section V.A of this document.

Table V.83 Summary of Analytical Results for CRE at all TSLs: National Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Cumulative FFC National Energy Savings					
FFC (Quads)	0.25	0.29	**1.11**	1.50	1.61
Cumulative FFC Emissions Reduction					
CO_2 (*million metric tons*)	4.39	5.09	**19.7**	26.7	28.6
CH_4 (*thousand tons*)	37.4	43.3	**168**	228	243
N_2O (*thousand tons*)	0.04	0.05	**0.19**	0.26	0.28
NO_x (*thousand tons*)	8.23	9.52	**36.9**	50.0	53.5
SO_2 (*thousand tons*)	1.34	1.55	**6.02**	8.14	8.71
Hg (*tons*)	0.01	0.01	**0.04**	0.06	0.06
Present Value of Benefits and Costs (*3% discount rate, billion 2023$*)					
Consumer Operating Cost Savings	0.84	1.02	**4.61**	6.90	7.40
Climate Benefits* (2023 SC-GHG)	1.03	1.19	**4.60**	6.23	6.66
Climate Benefits* (2021 interim SC-GHG estimates)	0.25	0.29	**1.12**	1.51	1.62
Health Benefits**	0.49	0.57	**2.19**	2.97	3.17
Total Benefits† (2023 SC-GHG estimates)	2.35	2.77	**11.4**	16.1	17.2
Total Benefits† (2021 interim SC-GHG estimates)	1.58	1.87	**7.92**	11.38	12.19
Consumer Incremental Equipment Costs‡	0.24	0.27	**1.18**	5.02	15.8
Consumer Net Benefits	0.60	0.74	**3.43**	1.89	-8.45
Net Benefits† (2023 SC-GHG estimates)	2.12	2.50	**10.2**	11.1	1.39
Net Benefits† (2021 interim SC-GHG estimates)	1.34	1.60	**6.74**	6.36	-3.66
Present Value of Benefits and Costs (*7% discount rate, billion 2023$*)					
Consumer Operating Cost Savings	0.36	0.44	**1.99**	2.97	3.19
Climate Benefits* (2023 SC-GHG estimates)	1.03	1.19	**4.60**	6.23	6.66
Climate Benefits* (2021 interim SC-GHG estimates)	0.25	0.29	**1.12**	1.51	1.62
Health Benefits**	0.19	0.22	**0.86**	1.16	1.24
Total Benefits† (2023 SC-GHG estimates)	1.58	1.85	**7.45**	10.4	11.1
Total Benefits† (2021 interim SC-GHG estimates)	0.80	0.95	**3.96**	5.64	6.04
Consumer Incremental Equipment Costs‡	0.13	0.15	**0.67**	2.75	8.55
Consumer Net Benefits	0.24	0.29	**1.32**	0.22	-5.36
Net Benefits† (2023 SC-GHG estimates)	1.45	1.70	**6.78**	7.61	2.54
Net Benefits† (2021 interim SC-GHG estimates)	0.68	0.80	**3.29**	2.89	-2.51

Note: This table presents the costs and benefits associated with CRE shipped during the period 2029−2058. These results include benefits to consumers which accrue after 2058 from the equipment shipped during the period 2029−2058. TSL 3 (highlighted) is the selected TSL.
* Climate benefits are calculated different estimates of the SC-CO2, SC-CH4 and SC-N2O. 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_X and SO_2. DOE is currently only monetizing (for NO_X and SO_2) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 21 Sectors* TSD provides a summary of the health impact endpoints quantified in the analysis. The health benefits are presented at real discount rates of 3 and 7 percent. See section IV.L of this document for more details.
† Total and net benefits include consumer, climate, and health benefits. For presentation purposes, total and net 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.
‡ Costs include incremental equipment costs.

Table V.84 Summary of Analytical Results for CRE TSLs: Manufacturer and Consumer Impacts

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5
Manufacturer Impacts					
Industry NPV (*million 2023$*) (No-new-standards case INPV = 3,022.3)	2,997.6 to 3,001.5	2,994.8 to 2,999.2	2,943.6 to 2,971.0	2,862.2 to 2,958.8	2,800.6 to 3,077.5
Industry NPV (*% change*)	(0.8) to (0.7)	(0.9) to (0.8)	(2.6) to (1.7)	(5.3) to (2.1)	(7.3) to 1.8
Consumer Average LCC Savings (2023$)					
CB.SC.L	44.3	75.4	163.6	163.6	163.6
CB.SC.M	24.6	46.4	8.1	8.1	8.1
HCS.SC.L	24.1	24.1	24.1	24.1	24.1
HCS.SC.M	12.4	18.9	18.9	18.9	18.9
HCT.SC.I	26.7	29.3	29.3	29.3	(309.8)
HCT.SC.L	n/a	n/a	n/a	n/a	(430.4)
HCT.SC.M	n/a	n/a	n/a	n/a	(340.7)
HZO.RC.L	n/a	n/a	n/a	n/a	n/a
HZO.RC.M	n/a	n/a	n/a	n/a	n/a
HZO.SC.L	54.0	54.0	1,243.6	1,243.6	1,243.6
HZO.SC.M	39.2	39.2	312.9	312.9	312.9
SOC.RC.M	n/a	n/a	n/a	743.4	(181.4)
SOC.SC.M	441.5	481.5	443.5	183.2	183.2
SVO.RC.M	97.1	97.1	97.1	473.0	473.0
SVO.SC.M	430.2	576.1	578.9	642.4	642.4
VCS.SC.H	9.8	9.8	9.8	9.8	(57.7)
VCS.SC.I	45.1	70.8	488.2	488.2	488.2
VCS.SC.L	43.3	88.0	470.5	470.5	470.5
VCS.SC.M	29.1	29.1	29.1	(42.0)	(42.0)
VCT.RC.L	n/a	n/a	n/a	(182.9)	(3,080.4)

VCT.RC.M	n/a	n/a	n/a	(108.3)	(3,333.3)
VCT.SC.H	14.6	19.3	19.3	19.3	(1,467.3)
VCT.SC.I	n/a	n/a	n/a	n/a	(990.6)
VCT.SC.L	45.2	45.2	436.9	(809.8)	(809.8)
VCT.SC.M	28.0	28.0	33.2	(66.0)	(1,421.6)
VOP.RC.L	1,300.4	1,300.4	1,300.4	1,529.7	1,529.7
VOP.RC.M	337.4	337.4	337.4	798.0	798.0
VOP.SC.M	604.6	915.5	1,867.5	1,945.9	1,945.9
Shipment-Weighted Average*	42.8	49.8	115.8	8.3	(606.9)
Consumer Simple PBP (years)					
CB.SC.L	1.2	1.8	4.0	4.0	4.0
CB.SC.M	1.9	2.8	6.8	6.8	6.8
HCS.SC.L	3.2	3.2	3.2	3.2	3.2
HCS.SC.M	3.9	4.0	4.0	4.0	4.0
HCT.SC.I	7.1	7.0	7.0	7.0	20.5
HCT.SC.L	n/a	n/a	n/a	n/a	52.6
HCT.SC.M	n/a	n/a	n/a	n/a	114.9
HZO.RC.L	n/a	n/a	n/a	n/a	n/a
HZO.RC.M	n/a	n/a	n/a	n/a	n/a
HZO.SC.L	1.8	1.8	2.4	2.4	2.4
HZO.SC.M	2.3	2.3	2.6	2.6	2.6
SOC.RC.M	n/a	n/a	n/a	4.8	18.3
SOC.SC.M	0.5	0.7	2.4	7.0	7.0
SVO.RC.M	2.4	2.4	2.4	3.5	3.5
SVO.SC.M	0.9	1.0	4.1	4.4	4.4
VCS.SC.H	4.0	4.0	4.0	4.0	9.8
VCS.SC.I	1.2	1.8	3.1	3.1	3.1
VCS.SC.L	1.2	1.8	2.2	2.2	2.2
VCS.SC.M	3.0	3.0	3.0	9.6	9.6
VCT.RC.L	n/a	n/a	n/a	16.8	57.3
VCT.RC.M	n/a	n/a	n/a	19.8	107.3
VCT.SC.H	2.7	4.0	4.0	4.0	69.2
VCT.SC.I	n/a	n/a	n/a	n/a	39.0
VCT.SC.L	2.2	2.2	3.5	16.9	16.9
VCT.SC.M	3.1	3.1	6.5	11.6	55.6
VOP.RC.L	0.9	0.9	0.9	1.6	1.6
VOP.RC.M	1.8	1.8	1.8	2.7	2.7
VOP.SC.M	0.7	0.9	1.4	1.8	1.8
Shipment-Weighted Average*	2.4	2.5	3.5	9.5	27.9
Percent of Consumers that Experience a Net Cost					
CB.SC.L	0%	0%	9%	9%	9%
CB.SC.M	0%	1%	26%	26%	26%
HCS.SC.L	4%	4%	4%	4%	4%
HCS.SC.M	3%	9%	9%	9%	9%
HCT.SC.I	10%	10%	10%	10%	59%
HCT.SC.L	n/a	n/a	n/a	n/a	61%

HCT.SC.M	n/a	n/a	n/a	n/a	86%
HZO.RC.L	n/a	n/a	n/a	n/a	n/a
HZO.RC.M	n/a	n/a	n/a	n/a	n/a
HZO.SC.L	0%	0%	0%	0%	0%
HZO.SC.M	0%	0%	1%	1%	1%
SOC.RC.M	n/a	n/a	n/a	16%	37%
SOC.SC.M	0%	0%	4%	23%	23%
SVO.RC.M	26%	26%	26%	15%	15%
SVO.SC.M	0%	0%	12%	10%	10%
VCS.SC.H	6%	6%	6%	6%	59%
VCS.SC.I	0%	0%	4%	4%	4%
VCS.SC.L	0%	0%	0%	0%	0%
VCS.SC.M	3%	3%	3%	52%	52%
VCT.RC.L	n/a	n/a	n/a	70%	86%
VCT.RC.M	n/a	n/a	n/a	32%	56%
VCT.SC.H	1%	7%	7%	7%	73%
VCT.SC.I	n/a	n/a	n/a	n/a	48%
VCT.SC.L	0%	0%	7%	83%	83%
VCT.SC.M	3%	3%	25%	45%	61%
VOP.RC.L	0%	0%	0%	3%	3%
VOP.RC.M	4%	4%	4%	7%	7%
VOP.SC.M	0%	0%	0%	0%	0%
Shipment-Weighted Average*	2%	3%	9%	40%	48%

Parentheses indicate negative (-) values. The entry "n/a" means not applicable because there is no change in the standard at certain TSLs.
* Weighted by shares of each equipment class in total projected shipments in 2029.

This section discusses DOE's conclusions regarding CRE connected to a remote condensing unit and non-large CRE connected to a self-contained unit. As discussed previously in sections I and II.B.3 of this document, DOE is continuing to analyze the large-capacity 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.

DOE first considered TSL 5, which represents the max-tech efficiency levels for all equipment classes. The design options DOE analyzed at this level include the max-tech technologies for all equipment classes. DOE expects manufacturers would likely need to incorporate occupancy sensors with dimming capability for all vertical and semi-vertical open and all transparent door equipment classes. Vertical and semi-vertical open equipment classes would also likely necessitate the use of night curtains. For equipment classes with transparent doors, DOE expects manufacturers would likely need to incorporate vacuum-insulated glass doors. For most self-contained equipment, DOE expects manufacturers would likely need to incorporate variable-speed compressors. For all self-contained equipment classes, DOE expects manufacturers would likely incorporate EC evaporator and condenser fan motors.

TSL 5 would save an estimated 1.61 quads of FFC energy over 30 years of shipments (2029 to 2058), an amount DOE considers significant. Under TSL 5, the NPV of consumer benefits would be -$5.36 billion using a discount rate of 7 percent, and -$8.45 billion using a discount rate of 3 percent for the same 30-year period.

The cumulative emissions reductions at TSL 5 are 28.6 Mt of CO_2, 8.71 thousand tons of SO_2, 53.5 thousand tons of NO_X, 0.06 tons of Hg, 243 thousand tons of CH_4, and 0.28 thousand tons of N_2O for the same 30-year period. The estimated monetary value of the climate benefits from reduced GHG emissions (associated with the average 2023 SC-GHG estimates at a 2-percent, near-term Ramsey discount rate) at TSL 5 is $6.66 billion, and the climate benefits associated with the average 2021 Interim SC-GHG estimates at a 3-percent discount rate are estimated to be $1.62 billion. The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 5 is $1.24 billion using a 7-percent discount rate and $3.17 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X emissions, and either the 2-percent near-term Ramsey discount rate case for climate benefits from reduced GHG emissions, or the 3-percent discount rate case for climate benefits from reduced GHG emissions, the estimated total NPV at TSL 5 is $2.54 billion (using the 2023 SC-GHG estimates) or -$2.51 billion (using the 2021 interim SC-GHG estimates). Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and either the 2-percent discount rate case for climate benefits from reduced GHG emissions or 3-percent discount rate case for , the estimated total NPV at TSL 5 is $1.39 billion (using the 2023 SC-GHG estimates) or -$3.66 billion (using the 2021 interim SC-GHG estimates). The estimated total NPV is provided for additional information; however, DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 5, affected purchasers of CRE experience average LCC savings ranging from -$3,333 to $1,946 with a payback period ranging from 1.6 years to 114.9 years. The LCC savings are negative for 12 of the 28 analyzed equipment classes, representing 78 percent of annual shipments. For example, the equipment class with the highest annual shipments volume (VCS.SC.M), representing approximately 36 percent of annual CRE shipments, has negative LCC savings of -$42 with 52 percent of consumers experiencing a net cost, and a PBP of 9.6 years. The second-highest equipment class in terms of annual units shipped (VCT.SC.M), representing about 25 percent of annual CRE shipments, has negative LCC savings of -$1,422 with 61 percent of consumers experiencing a net cost, and a PBP of 55.6 years. Overall, almost half of CRE purchasers (48 percent) experience a net cost. Furthermore, the shipment-weighted-average PBP is estimated at 27.8 years, which is generally higher than the average CRE lifetime, while the shipment-weighted-average LCC savings is negative, at -$608.

At TSL 5, the projected change in INPV ranges from a decrease of $221.7 million to an increase of $55.2 million, which corresponds to a decrease of 7.3 percent and an increase of 1.8 percent, respectively. DOE estimates that manufacturers would need to invest $254.1 million to update equipment designs and source, qualify, and test high-efficiency components across their entire CRE portfolio. DOE estimates that approximately 55 percent of analyzed equipment class model listings in its CCD (10,957 unique basic models out of a total of 19,902) do not meet the max-tech efficiency levels required.

At this level, although most design options would not necessitate purchasing new equipment or significant capital investment, nearly all manufacturers would need to spend notable development time incorporating the analyzed max-tech design options across their entire CRE portfolio. For the 84 manufacturers that offer CRE with transparent doors (which account for approximately 41 percent of model listings), implementing vacuum-insulated glass would require significant engineering resources and testing time to ensure adequate safety and durability of their equipment in all commercial settings. In interviews, most manufacturers raised concerns about standards requiring a widespread adoption of vacuum-insulated glass as it is still a relatively new technology in the commercial refrigeration market. Manufacturers pointed to the very limited industry experience with implementing vacuum-insulated glass in CRE applications. In addition to incorporating vacuum-insulated glass into transparent door CRE designs, DOE expects most manufacturers would have to invest in extensive redesign and development to incorporate variable-speed compressors across nearly all self-contained CRE models.

Based on this analysis, the Secretary concludes that at TSL 5 for CRE, the benefits of energy savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the negative NPV of consumer benefits, economic burden on many CRE purchasers, and the impacts on manufacturers, including the conversion costs impacts that could result in a reduction in INPV. For the manufacturers of CRE with transparent doors implementing vacuum-insulated glass would require significant engineering resources and testing time to ensure adequate safety and durability of their equipment in all commercial settings. Almost half of CRE purchasers (48 percent) experience a net cost. Furthermore, the shipment-weighted average LCC savings are negative (-$608) and the shipment-weighted average PBP exceeds the average CRE lifetime, at 27.8 years. Consequently, the Secretary has concluded that TSL 5 is not economically justified.

DOE then considered TSL 4, an intermediate TSL representing less stringent efficiency levels for approximately one-third of the equipment classes analyzed compared to TSL 5. DOE expects manufacturers would likely need to incorporate occupancy sensors with dimming capability for all vertical and semi-vertical open and most transparent door equipment classes. Vertical and semi-vertical open equipment classes would also likely necessitate the use of night curtains. For most equipment classes with transparent doors, DOE expects manufacturers would incorporate triple-pane, argon-filled glass doors, triple-pane, krypton-filled glass doors, or vacuum-insulated glass doors. For most self-contained equipment classes, DOE expects manufacturers would likely need to incorporate variable-speed compressors. For all self-contained equipment classes, DOE expects manufacturers would likely incorporate EC evaporator and condenser fan motors.

TSL 4 would save an estimated 1.50 quads of full fuel cycle energy over 30 years of shipments (2029 to 2058), an amount DOE considers significant. Under TSL 4, the NPV of consumer benefit would be $0.22 billion using a discount rate of 7 percent, and $1.89 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 4 are 26.7 Mt of CO_2, 8.14 thousand tons of SO_2, 50 thousand tons of NO_X, 0.06 tons of Hg, 228 thousand tons of CH_4, and 0.26 thousand tons of N_2O. The estimated monetary value of the climate benefits from reduced GHG emissions at TSL 4 is $6.23 billion (using the 2023 SC-GHG estimates at a 2-percent near-term Ramsey discount rate) or $1.51 billion (using 2021 interim SC-GHG estimates at an average 3-percent discount rate). The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 4 is $1.16 billion using a 7-percent discount rate and $2.97 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X 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 total NPV at TSL 4 is $7.61 billion (using the 2023 SC-GHG estimates) or $2.89 billion (using the 2021 interim SC-GHG estimates). Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 emissions, and 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 total NPV at TSL 4 is $11.08 billion (using the 2023 SC-GHG estimates) or $6.36 billion (using the 2021 interim SC-GHG estimates). The estimated total NPV is provided for additional information, however, DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

At TSL 4, affected purchasers for each CRE equipment class experience average LCC savings ranging from -$810 to $1,946 with a payback period ranging from 1.6 years to 19.8 years. The LCC savings are negative for 5 of the 28 analyzed equipment classes, representing 75 percent of annual shipments. For example, the equipment class with the highest annual shipments volume (VCS.SC.M), representing approximately 36 percent of annual CRE shipments, has negative LCC savings of -$42 with 52 percent of consumers experiencing a net cost, and a PBP of 9.6 years. The second-highest equipment class in terms of annual units shipped (VCT.SC.M), representing about 25 percent of annual CRE shipments, has negative LCC savings of -$66 with 45 percent of consumers experiencing a net cost, and a PBP of 11.6 years. Overall, approximately 40 percent of affected CRE purchasers would experience a net cost, while 27 percent would experience a net benefit, and the remaining purchasers would be unaffected at TSL 4. In addition, the estimated shipment-weighted average LCC savings for all CRE is $8 and the shipment-weighted average PBP is 9.5 years.

At TSL 4, the projected change in INPV ranges from a decrease of $160.1 million to a decrease of $63.5 million, which correspond to decreases of 5.3 percent and 2.1 percent, respectively. DOE estimates that industry would need to invest $223.9 million to comply with standards set at TSL 4. Similar to TSL 5, DOE estimates that over half of CRE models would require redesign to meet standards set at TSL 4. Specifically, DOE estimates that approximately 53 percent of analyzed equipment class model listings in its CCD (10,574 unique basic models out of a total of 19,902) do not meet the TSL 4 efficiency levels.

Similar to TSL 5, DOE expects manufacturers would need to dedicate notable engineering resources and time to update equipment designs and source, qualify, and test high-efficiency components. DOE also expects some manufacturers would need to invest in new tooling to accommodate the additional door thickness associated with incorporating additional panes of glass into CRE designs. At this level, DOE expects 7 out of the 11 directly analyzed transparent door equipment classes would likely necessitate vacuum-insulated glass doors or other improved door designs. Specifically, DOE expects SOC.SC.M and VCT.SC.L (which represent approximately 9 percent of transparent door CRE model listings) would incorporate vacuum-insulated glass doors, SOC.RC.M, VCT.RC.L, and VCT.RC.M (which represent approximately 63 percent of transparent door CRE model listings) would incorporate triple-pane glass doors with krypton fill, and HCT.SC.I and VCT.SC.M (which represent approximately 25 percent of transparent door CRE model listings) would incorporate triple-pane glass doors with argon fill at this level. As previously discussed, many manufacturers raised concerns about the widespread adoption of vacuum-insulated glass because the industry does not have widescale experience integrating this technology into their designs. In interviews and public comments, some manufacturers also raised concerns about the limited supply of krypton gas available to the market. (Hillphoenix, No. 77 at p. 6; Zero Zone, No. 75 at pp. 3–4) Currently, few CRE designs have triple-pane glass doors with krypton fill as nearly all CRE with double-pane or triple-pane doors are manufactured with argon fill, and single-pane doors do not have an inert gas fill. At this level, DOE expects most self-contained equipment classes (representing approximately 90 percent of self-contained CRE model listings) would likely necessitate the use of variable-speed compressors. Therefore, DOE expects most manufacturers would still have to invest in significant redesign and development time to optimize variable-speed compressors to ensure energy efficiency benefits across the majority of self-contained CRE designs.

Most CRE manufacturers offer an exhaustive range of model offerings to appeal to the unique requirements of each CRE consumer. Within a model family, manufacturers offer numerous options to customize CRE to the specifications of restaurant, supermarket, and retail chains and other bulk purchasers of CRE (*e.g.*, Coca-Cola, Pepsi). In interviews, many manufacturers noted that offering a wide-range of models with a high-level of customization and optionality (*e.g.*, different evaporator setups, different lighting arrangements, different door configurations, *etc*.) is critical to succeed in the CRE market. Many manufacturers prioritize offering a breadth of model offerings and specialty CRE, even if sales of each individual model are low. As such, manufacturers still offer hundreds of basic models for equipment classes with low annual shipments. For example, SOC.RC.M accounts for approximately 5 percent of model listings (over 1,000 unique basic models certified in DOE's CCD) even though SOC.RC.M only accounts for 0.1 percent of industry shipments (less than 2,000 units sold in 2024).

Multiple stakeholders raised concerns about the risk that stringent standards and limited laboratory and engineering resources would force manufacturers to discontinue certain equipment designs and prioritize redesigning high-volume model offerings. (Continental, No. 107 at p. 3; Continental, No. 86 at p. 6; NAFEM, No. 87 at p. 2; Structural Concepts, No. 74 at p. 4) Some manufacturers expressed concern that the discontinuation of model offerings could lead to equipment commoditization where equipment can only compete on price rather than value-added options and features. In addition to the impacts that extensive redesign and testing may have on CRE manufacturers overall, it would also disproportionately impact small businesses, which typically have limited personnel, engineering, and laboratory resources relative to larger CRE manufacturers and account for approximately 20 percent of CRE manufacturers (20 out of 103 OEMs).

Based on this analysis, the Secretary concludes that at TSL 4 for CRE, the benefits of energy savings, emission reductions, and the estimated monetary value of the emissions reductions would be outweighed by the economic burden on a large fraction of CRE purchasers, the risk of reduced customization and optionality if manufacturers have insufficient resources to redesign their full portfolio of models within the compliance period, the impacts on manufacturers including small businesses, including the conversion costs that could result in a reduction in INPV, and limited industry experience with vacuum-insulated glass doors in commercial applications. If manufacturers do not have sufficient resources to redesign models within the compliance period, manufacturers would likely discontinue low-volume equipment designs and prioritize redesigning high-volume model offerings, potentially leading to equipment commoditization. Finally, although the shipments-weighted average LCC savings for all CRE are marginally positive (at $8), overall the LCC savings are negative for five equipment classes representing 75 percent of annual shipments. Consequently, the Secretary has concluded that TSL 4 is not economically justified.

DOE then considered TSL 3, an intermediate TSL representing less stringent efficiency levels for 12 equipment classes compared to TSL 4. In contrast to TSL 4 and TSL 5, DOE expects that manufacturers could meet TSL 3 efficiencies without incorporating occupancy sensors with dimming capability into vertical and semi-vertical open and transparent door CRE designs, and without use of vacuum-insulated-glass or triple-pane glass with krypton fill into transparent door CRE designs. For vertical and semi-vertical open equipment classes, DOE expects manufacturers would likely require the use of night curtains. For some equipment classes with transparent doors, DOE expects manufacturers would incorporate triple-pane, argon-filled glass doors. For all self-contained equipment classes, DOE expects manufacturers would incorporate EC evaporator and condenser fan motors. For most self-contained equipment classes, DOE expects manufacturers would likely need to incorporate variable-speed compressors. DOE also expects that, given the reduced number of models requiring redesign at this TSL and the lower overall cost to implement this level compared with TSL 4, manufacturers would be able to continue to offer numerous options to customize CRE to the specifications of restaurant, supermarket, and retail chains and other bulk purchasers of CRE (*e.g*., Coca-Cola, Pepsi) and offer a wide-range of models with a high-level of customization and optionality (*e.g*., different evaporator setups, different lighting arrangements, different door configurations, *etc*.) which is critical to succeed in the CRE market.

TSL 3 would save an estimated 1.11 quads of full fuel cycle energy over 30 years of shipments (2029 to 2058), an amount DOE considers significant. Under TSL 3, the NPV of consumer benefit would be $1.32 billion using a discount rate of 7 percent, and $3.43 billion using a discount rate of 3 percent.

The cumulative emissions reductions at TSL 3 are 19.7 Mt of CO_2, 6.02 thousand tons of SO_2, 36.9 thousand tons of NO_X, 0.04 tons of Hg, 168 thousand tons of CH_4, and 0.19 thousand tons of N_2O. At TSL 3, the estimated monetary value of the climate benefits from reduced GHG emissions is $4.6 billion (using the SC-GHG estimates at a 2-percent near term Ramsey discount rate) or $1.12 billion (using the 2021 interim SC-GHG estimates at an average 3-percent discount rate) . The estimated monetary value of the health benefits from reduced SO_2 and NO_X emissions at TSL 3 is $0.86 billion using a 7-percent discount rate and $2.19 billion using a 3-percent discount rate.

Using a 7-percent discount rate for consumer benefits and costs, health benefits from reduced SO_2 and NO_X 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 total NPV at TSL 3 is $6.78 billion (using the 2023 SC-GHG estimates) or $3.29 billion (using the 2021 interim SC-GHG estimates). Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 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 total NPV at TSL 3 is $10.2 billion (using the 2023 SC-GHG estimates) or $6.74 billion (using the 2021 interim SC-GHG estimates). The estimated total NPV is provided for additional information, however, DOE primarily relies upon the NPV of consumer benefits when determining whether a proposed standard level is economically justified.

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. For example, for equipment classes VCS.SC.M, VCT.SC.M, VCS.SC.L, and VCT.SC.L, which account for 77 percent of annual CRE shipments, there is a net LCC savings of $29, $33, $471, and $437 and a PBP of 3.0, 6.5, 2.2, and 3.5 years, respectively. Overall, approximately 91 percent of affected CRE purchasers would experience a net benefit or not be affected at TSL 3. Furthermore, the estimated shipment-weighted-average LCC savings is $116 and PBP is 3.5 years, which is lower than the average CRE lifetime.

At TSL 3, the projected change in INPV ranges from a decrease of $78.7 million to a decrease of $51.3 million, which correspond to decreases of 2.6 percent and 1.7 percent, respectively. DOE estimates that industry must invest $117.7 million to comply with standards set at TSL 3. At this level, notably fewer models would require redesign compared to TSL 4 and TSL 5. DOE estimates that approximately 37 percent of analyzed equipment class model listings in its CCD (7,306 unique basic models out of a total of 19,902) do not meet the TSL 3 efficiency levels required.

Similar to TSL 4 and TSL 5, DOE expects manufacturers would spend development time updating equipment designs to incorporate high-efficiency components. However, DOE expects manufacturers could meet TSL 3 without implementing triple-pane doors with krypton fill or vacuum-insulated glass doors, alleviating industry concerns about the availability and supply of krypton gas and vacuum-insulated glass. Additionally, DOE expects fewer equipment classes would necessitate the use of variable-speed compressors. At TSL 3, approximately 63 percent of self-contained CRE model listings may need to incorporate variable-speed compressors, significantly less than at TSL 4 where DOE expects 90 percent of self-contained CRE model listings would necessitate the use of variable-speed compressors. Since the majority of basic models (63 percent of model listings) already meet TSL 3 efficiencies, the estimated industry investment and strain on manufacturers' testing facilities and engineering resources would be less at TSL 3 than at TSL 4 and TSL 5, reducing the risk that manufacturers would need to prioritize resources and discontinue low-volume CRE designs.

After considering the analysis and weighing the benefits and burdens, the Secretary has concluded that a standard set at TSL 3 for CRE would be economically justified. At this TSL, the average LCC savings for all affected purchasers are positive. An estimated 42 percent of purchasers experience a net benefit, while 9 percent of purchasers experience a net LCC cost. The FFC national energy savings are significant and the NPV of consumer benefits is positive using both a 3-percent and 7-percent discount rate. Notably, the benefits to consumers vastly outweigh the cost to manufacturers. At TSL 3, the NPV of consumer benefits, even measured at the more conservative discount rate of 7 percent is over 16 times higher than the maximum estimated manufacturers' loss in INPV. The standard levels at TSL 3 are economically justified even without weighing the estimated monetary value of emissions reductions. When those emissions reductions are included—representing $4.6 billion in climate benefits (associated with the average SC-GHG at a 2-percent near-term Ramsey discount rate), and $2.19 billion (using a 3-percent discount rate) or $0.86 billion (using a 7-percent discount rate) in health benefits—the rationale becomes stronger still.

As stated, DOE conducts the walk-down analysis to determine the TSL that represents the maximum improvement in energy efficiency that is technologically feasible and economically justified as required under EPCA. The walk-down is not a comparative analysis, as a comparative analysis would result in the maximization of net benefits instead of energy savings that are technologically feasible and economically justified, which would be contrary to the statute. 86 FR 70892, 70908. Although DOE has not conducted a comparative analysis to select the amended energy conservation standards, DOE notes that as compared to TSL 5 and TSL 4, TSL 3 has a lower maximum decrease in INPV and lower manufacturer conversion costs. Furthermore, DOE notes that notably more basic models meet TSL 3 compared TSL 4 and TSL 5, reducing the amount of time and investment associated with redesigning and testing CRE models.

Finally, compared to TSL 5 and TSL 4, TSL 3 results in the highest consumer NPV and positive LCC savings for all CRE equipment classes, while PBPs for each equipment class are considerably less than the average CRE lifetime. In addition, 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.

Therefore, based on the previous considerations, DOE adopts the energy conservation standards for CRE at TSL 3. The new and amended energy conservation standards for CRE, which are expressed as kWh/day, are shown in Table V.85.

Table V.85 New and Amended Energy Conservation Standards for CRE

Equipment Class	Capacity Range	Maximum Daily Energy Consumption *kWh/day*
VOP.RC.H	All TDAs are applicable	0.551 × TDA + 3.506
VOP.RC.M	All TDAs are applicable	0.591 × TDA + 3.758
VOP.RC.L	All TDAs are applicable	2.079 × TDA + 6.472
VOP.RC.I	All TDAs are applicable	2.637 × TDA + 8.222
SVO.RC.H	All TDAs are applicable	0.572 × TDA + 2.756
SVO.RC.M	All TDAs are applicable	0.611 × TDA + 2.944
SVO.RC.L	All TDAs are applicable	2.079 × TDA + 6.473
SVO.RC.I	All TDAs are applicable	2.637 × TDA + 8.222
HZO.RC.H	All TDAs are applicable	0.350 × TDA + 2.880
HZO.RC.M	All TDAs are applicable	0.350 × TDA + 2.880
HZO.RC.L	All TDAs are applicable	0.550 × TDA + 6.880
HZO.RC.I	All TDAs are applicable	0.700 × TDA + 8.740
VCT.RC.H	All TDAs are applicable	0.150 × TDA + 1.950
VCT.RC.M	All TDAs are applicable	0.150 × TDA + 1.950
VCT.RC.L	All TDAs are applicable	0.490 × TDA + 2.610
VCT.RC.I	All TDAs are applicable	0.580 × TDA + 3.050
HCT.RC.M	All TDAs are applicable	0.160 × TDA + 0.130
HCT.RC.L	All TDAs are applicable	0.340 × TDA + 0.260
HCT.RC.I	All TDAs are applicable	0.356 × TDA + 0.276
VCS.RC.H	All volumes are applicable	0.100 × V + 0.260
VCS.RC.M	All volumes are applicable	0.100 × V + 0.260
VCS.RC.L	All volumes are applicable	0.210 × V + 0.540
VCS.RC.I	All volumes are applicable	0.250 × V + 0.630
HCS.RC.M	All volumes are applicable	0.100 × V + 0.260
HCS.RC.L	All volumes are applicable	0.210 × V + 0.540
HCS.RC.I	All volumes are applicable	0.250 × V + 0.630
SOC.RC.H	All TDAs are applicable	0.440 × TDA + 0.110
SOC.RC.M	All TDAs are applicable	0.440 × TDA + 0.110
SOC.RC.L	All TDAs are applicable	0.930 × TDA + 0.220
SOC.RC.I	All TDAs are applicable	0.970 × TDA + 0.231
CB.RC.M	All volumes are applicable	0.050 × V + 0.686
CB.RC.L	All volumes are applicable	0.194 × V + 1.693
VOP.SC.H	All TDAs are applicable	0.890 × TDA + 2.480[160]
VOP.SC.M – Non-Large	TDA ≤ 17	1.230 × TDA + 3.428
VOP.SC.M – Large***	TDA > 17	1.690 × TDA + 4.710
VOP.SC.L	All TDAs are applicable	3.092 × TDA + 8.598

[160] The equation for VOP.SC.H was written incorrectly in the August 2024 NODA Support Document and has been corrected here which is consistent with the secondary mapping in Table 4.1 of the August 2024 NODA.

VOP.SC.I	All TDAs are applicable	3.928 × TDA + 10.926
SVO.SC.H	All volumes are applicable	1.045 × TDA + 2.822
SVO.SC.M – Non-Large	TDA ≤ 15	1.207 × TDA + 3.258
SVO.SC.M – Large***	TDA > 15	1.700 × TDA + 4.590
SVO.SC.L	All TDAs are applicable	3.024 × TDA + 8.169
SVO.SC.I	All TDAs are applicable	3.840 × TDA + 10.384
HZO.SC.H	All TDAs are applicable	0.546 × TDA + 4.211
HZO.SC.M	All TDAs are applicable	0.532 × TDA + 4.100
HZO.SC.L – Non-Large	TDA ≤ 35	1.490 × TDA + 5.554
HZO.SC.L – Large***	TDA > 35	1.900 × TDA + 7.080
HZO.SC.I	All TDAs are applicable	1.900 × TDA + 7.065
VCT.SC.H	All volumes are applicable	0.047 × V + 0.493
VCT.SC.M – Non-Large	V ≤ 100	0.073 × V + 0.630
VCT.SC.M with Feature**	V ≤ 100	0.078 × V + 0.674
VCT.SC.M – Large***	V > 100	0.100 × V + 0.860
VCT.SC.L – Non-Large	V ≤ 70	0.233 × V + 2.374
VCT.SC.L with Feature**	V ≤ 70	0.249 × V + 2.540
VCT.SC.L – Large***	V > 70	0.290 × V + 2.950
VCT.SC.I	All TDAs are applicable	0.620 × TDA + 3.290
HCT.SC.M	All volumes are applicable	0.060 × V + 0.370
HCT.SC.L	All volumes are applicable	0.080 × V + 1.230
HCT.SC.I	All TDAs are applicable	0.498 × TDA + 0.383
VCS.SC.H	All volumes are applicable	0.021 × V + 0.793
VCS.SC.M	All volumes are applicable	0.038 × V + 1.039
VCS.SC.M with Feature**	All volumes are applicable	0.041 × V + 1.112
VCS.SC.L – Non-Large	V ≤ 100	0.169 × V + 1.050
VCS.SC.L with Feature**	V ≤ 100	0.181 × V + 1.133
VCS.SC.L – Large***	V > 100	0.220 × V + 1.380
VCS.SC.I	All volumes are applicable	0.264 × V + 0.683
HCS.SC.M	All volumes are applicable	0.037 × V + 0.675
HCS.SC.L	All volumes are applicable	0.055 × V + 1.033
HCS.SC.L with Feature**	All TDAs are applicable	0.059 × V + 1.105
HCS.SC.I	All volumes are applicable	0.313 × V + 0.811
SOC.SC.H	All TDAs are applicable	0.304 × TDA + 0.584
SOC.SC.M – Non-Large	TDA ≤ 40	0.356 × TDA + 0.685
SOC.SC.M – Large***	TDA > 40	0.520 × TDA + 1.000
SOC.SC.L	All TDAs are applicable	1.100 × TDA + 2.100
SOC.SC.I	All TDAs are applicable	1.530 × TDA + 0.360
CB.SC.M	All volumes are applicable	0.081 × V + 1.117
CB.SC.L	All volumes are applicable	0.297 × V + 2.591
PD.SC.M	All volumes are applicable	0.110 × V + 0.810

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 representative value of volume and TDA is the representative value of total display area as determined in accordance with the DOE test procedure at appendix B to subpart C of part 431and applicable sampling plans.
** 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.

Table V.86 Applicable Features for Equipment Classes with Feature for Maximum Daily Energy Consumption Standards for Commercial Refrigerators, Freezers, and Refrigerator-Freezers

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 Drawer units
VCS.SC.L (≤ 100)	Pass-through doors Roll-in doors Roll-through doors Drawer units
HCS.SC.L	Forced air evaporator

2. Annualized Benefits and Costs of the Adopted Standards

The benefits and costs of the adopted standards can also be expressed in terms of annualized values. The annualized net benefit is: (1) the annualized national economic value (expressed in 2023$) of the benefits from operating equipment that meet the adopted standards (consisting primarily of operating cost savings from using less energy), minus increases in equipment purchase costs; and (2) the annualized monetary value of the climate and health benefits.

Table V.87 shows the annualized values for CRE under TSL 3, expressed in million 2023$. The results under the primary estimate are as follows.

Using a 7-percent discount rate for consumer benefits and costs and NOx and SO_2 reduction health benefits, and a 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 adopted standards for CRE is $71 million per year in increased equipment installed costs, while the estimated annual benefits are $210 million from 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 from reduced NO_X and SO_2 emissions. In this case, 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).

Using a 3-percent discount rate for consumer benefits and costs and health benefits from reduced NOx and SO_2 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).

Table V.87 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**
3% discount rate			
Consumer Operating Cost Savings	265	254	278
Climate Benefits* (2023 SC-GHG estimates)	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)
7% discount rate			
Consumer Operating Cost Savings	210	202	220
Climate Benefits* (2023 SC-GHG estimates)	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

	Million 2023$/year		
	Primary Estimate	Low-Net-Benefits Estimate	High-Net-Benefits Estimate
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_X and SO_2. DOE is currently only monetizing (for SO_2 and NO_X) $PM_{2.5}$ precursor health benefits and (for NO_X) ozone precursor health benefits, but will continue to assess the ability to monetize other effects such as health benefits from reductions in direct $PM_{2.5}$ emissions. Table 5 of the EPA's *Estimating the Benefit per Ton of Reducing PM2.5 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 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.
‡ Costs include incremental equipment costs.
‡‡ 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 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.

3. Removal of Obsolete Provisions

The energy conservation standards for CRE, located at 10 CFR 431.66, currently contain provisions in paragraphs (b)-(d) for equipment manufactured before March 27, 2017. As such, the provisions in paragraphs (b)-(d) are now obsolete for any CRE manufactured on or after March 27, 2017. In this final rule, DOE is removing these obsolete provisions.

In addition, paragraph (a) of 10 CFR 431.66 currently contains definitions for the terms "AV", "V", and "TDA," which are similarly obsolete. The term "AV" is referenced only in paragraph (b)(1), which is now obsolete (as discussed in the previous paragraph). The definitions for the terms "V" and "TDA" are obsolete because the measurement instructions for volume and total display area were updated in the September 2023 Test Procedure Final Rule and are separately codified within appendix B to Subpart C of Part 431. For these reasons, in this final rule, DOE is removing paragraph (a) of 10 CFR 431.66.

Given the removal of paragraphs (a) through (d) of 10 CFR 431.66, this final rule redesignates paragraph (e)—which contains the currently applicable standards—as paragraph (a). DOE is codifying the new and amended standards enacted by this final rule at paragraph (b). Finally, this final rule redesignates paragraph (f) ("Exclusions") as paragraph (c).

VI. Procedural Issues and Regulatory Review

A. Review Under Executive Orders 12866, 13563, and 14094

Executive Order ("E.O.") 12866, "Regulatory Planning and Review," as supplemented and reaffirmed by E.O. 13563, "Improving Regulation and Regulatory Review," 76 FR 3821 (Jan. 21, 2011) and amended by E.O. 14094, "Modernizing Regulatory Review," 88 FR 21879 (April 11, 2023), requires agencies, to the extent permitted by law, to: (1) propose or adopt a regulation only upon a reasoned determination that its benefits justify its costs (recognizing that some benefits and costs are difficult to quantify); (2) tailor regulations to impose the least burden on society, consistent with obtaining regulatory objectives, taking into account, among other things, and to the extent practicable, the costs of cumulative regulations; (3) select, in choosing among alternative regulatory approaches, those approaches that maximize net benefits (including potential economic, environmental, public health and safety, and other advantages; distributive impacts; and equity); (4) to the extent feasible, specify performance objectives, rather than specifying the behavior or manner of compliance that regulated entities must adopt; and (5) identify and assess available alternatives to direct regulation, including providing economic incentives to encourage the desired behavior, such as user fees or marketable permits, or providing information upon which choices can be made by the public. DOE emphasizes as well that E.O. 13563 requires agencies to use the best available techniques to quantify anticipated present and future benefits and costs as accurately as possible. In its guidance, the Office of Information and Regulatory Affairs ("OIRA") in the Office of Management and Budget has emphasized that such techniques may include identifying changing future compliance costs that might result from technological innovation or anticipated behavioral changes. For the reasons stated in the preamble, this final regulatory action is consistent with these principles.

Section 6(a) of E.O. 12866 also requires agencies to submit "significant regulatory actions" to OIRA for review. OIRA has determined that this final regulatory action constitutes a "significant regulatory action" within the scope of section 3(f)(1) of E.O. 12866, as amended by E.O. 14094. Accordingly, pursuant to section 6(a)(3)(C) of E.O. 12866, DOE has provided to OIRA an assessment, including the underlying analysis, of benefits and costs anticipated from the final regulatory action, together with, to the extent feasible, a quantification of those costs; and an assessment, including the underlying analysis, of costs and benefits of potentially effective and reasonably feasible alternatives to the planned regulation, and an explanation why the planned regulatory action is preferable to the identified potential alternatives. These assessments are summarized in this preamble and further detail can be found in the technical support document for this rulemaking.

B. Review Under the Regulatory Flexibility Act

The Regulatory Flexibility Act (5 U.S.C. 601 *et seq*.) requires preparation of an initial regulatory flexibility analysis ("IRFA") and a final regulatory flexibility analysis ("FRFA") for any rule that by law must be proposed for public comment, unless the agency certifies that the rule, if promulgated, will not have a significant economic impact on a substantial number of small entities. As required by E.O. 13272, "Proper Consideration of Small Entities in Agency Rulemaking," 67 FR 53461 (Aug. 16, 2002), DOE published procedures and policies on February 19, 2003, to ensure that the potential impacts of its rules on small entities are properly considered during the rulemaking process. 68 FR 7990. DOE has made its procedures and policies available on the Office of the General Counsel's website (*www.energy.gov/gc/office-general-counsel*). DOE has prepared the following FRFA for the equipment that are the subject of this rulemaking.

For manufacturers of CRE, the SBA has set a size threshold, which defines those entities classified as "small businesses" for the purposes of the statute. DOE used the SBA's small business size standards to determine whether any small entities would be subject to the requirements of the rule. (*See* 13 CFR part 121.) The size standards are listed by North American Industry Classification System ("NAICS") code and industry description and are available at *www.sba.gov/document/support-table-size-standards*. Manufacturing of CRE is classified under NAICS 333415, "Air-Conditioning and Warm Air Heating Equipment and Commercial and Industrial Refrigeration Equipment Manufacturing." The SBA sets a threshold of 1,250 employees or fewer for an entity to be considered as a small business for this category.

1. Need for, and Objectives of, Rule

DOE is adopting new and amended energy conservation standards for CRE. EPCA authorizes DOE to regulate the energy efficiency of a number of consumer products and certain industrial equipment. Title III, Part C of EPCA, added by Pub. L. 95-619, Title IV, section 441(a) (42 U.S.C. 6311–6317, as codified), established the Energy Conservation Program for Certain Industrial Equipment, which sets forth a variety of provisions designed to improve energy efficiency. This equipment includes CRE, the subject of this document. (42 U.S.C. 6311(1)(E)) EPCA established standards for certain categories of CRE (42 U.S.C. 6313(c)(2)–(4)) and directs DOE to conduct future rulemakings to determine whether to amend these standards. (42 U.S.C. 6313(c)(6)(B)) On March 28, 2014, DOE published a final rule that prescribed the current energy conservation standards for CRE manufactured on and after March 27, 2017. 79 FR 17725. EPCA provides that, 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 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))

2. Significant Issues Raised by Public Comments in Response to the IRFA

In response to the October 2023 NOPR, AHRI provided a list of known suppliers of CRE sold in the United States that are not listed on the CCD site: Amtecko 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[161] supplemented by information from CEC's MAEDbS,[162] company websites, and prior CRE rulemakings. To identify chef bases or griddle stands and high-temperature units, DOE

[161] U.S. Department of Energy's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (last accessed Jan. 31, 2024).
[162] California Energy Commission's Modernized Appliance Efficiency Database is available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed Jan. 31, 2024).

reviewed publicly available data from web scraping of company websites. DOE then reviewed its comprehensive equipment database to identify the 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 manufacturer assessment to include 10 additional manufacturers, including 2 additional OEMs, Atlantic Food Bars and Borgen Merchandising Systems, for this final rule.

In response to the October 2023 NOPR and August 2024 NODA, NAMA commented the refrigerant transition is a large burden for smaller manufacturers investing in safety compliance to low-GWP refrigerants, capital improvements to factories, changes to service, and training of factory employees and service providers. (NAMA, No. 85 at p. 4; NAMA, No. 112 at p. 5)

In response to NAMA, DOE notes that it considered the October 2023 EPA Final Rule and the expenses associated with the refrigerant transition in the analytical baseline of the October 2023 NOPR, August 2024 NODA, and this final rule analysis. 88 FR 70196, 70284; 88 FR 70247, 68800. Although refrigerant transition costs associated with the October 2023 EPA Final Rule are not attributed to this rulemaking, DOE accounted for these refrigerant transition costs in the no-new-standards case and standards cases to better reflect industry finances and cash flow over the analysis period. Since industry would incur costs associated with the refrigerant transition regardless of any DOE rulemaking, this FRFA assesses the potential small business investments incurred as a direct result of this DOE rulemaking. DOE reviewed this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990, 7993. See section V.B.2.e of this document for additional discussion of how DOE accounts for cumulative regulatory burden in its analysis.

In response to the October 2023 NOPR, Continental stated that adopting the standards proposed in the October 2023 NOPR with a 3-year lead-in would force them to exit in the market for many equipment configurations, which could negatively impact domestic employment and small businesses. (Continental, No. 86 at p. 6)

In response to the comment from Continental, DOE understands that small businesses could be affected disproportionately by amended standards. DOE analyzes the potential impacts of this final rule on small business manufacturers of CRE in section VI.B.5 of this document. As discussed in section III.A.2.a of this document, 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. Furthermore, DOE notes that compared to the October 2023 NOPR, DOE is adopting less stringent standards for 22 out of the 28 directly analyzed equipment classes. See section VI.B.5 of this document for an analysis of the estimated conversion costs small businesses may incur as a result of this final rule.

3. Response to Comments Filed by Chief Counsel for Advocacy of the Small Business Administration

The SBA's Chief Counsel for Advocacy did not submit public comments on this rulemaking.

4. Description and Estimated Number of Small Entities Affected

DOE reviewed this final rule under the provisions of the Regulatory Flexibility Act and the procedures and policies published on February 19, 2003. 68 FR 7990. DOE conducted a market assessment to identify potential small manufacturers of CRE. DOE began its assessment by compiling an equipment database of CRE models available in the United States. As discussed in section VI.B.2 of this document, to develop a comprehensive equipment database of CRE basic models, DOE reviewed its CCD[163] supplemented by information from CEC's MAEDbS,[164] individual company websites, stakeholder comments (AHRI, No. 81 at p. 6), and prior CRE rulemakings. 79 FR 17725. 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 the comprehensive equipment database to identify the companies that sell the CRE models identified. DOE then consulted publicly available data, such as manufacturer websites, manufacturer specifications and equipment literature, import/export logs (*e.g.*, bills of lading from ImportYeti[165]), and basic model numbers, to identify OEMs of CRE covered by this rulemaking. DOE further relied on public data and subscription-based market research tools (*e.g.*, Dun & Bradstreet reports[166]) to determine company, location, headcount, and annual revenue. DOE also asked industry

[163] U.S. Department of Energy's Compliance Certification Database is available at *www.regulations.doe.gov/certification-data/#q=Product_Group_s%3A** (last accessed Jan. 31, 2024).
[164] California Energy Commission's Modernized Appliance Efficiency Database is available at *cacertappliances.energy.ca.gov/Pages/Search/AdvancedSearch.aspx* (last accessed Jan. 31, 2024).
[165] ImportYeti, LLC. "ImportYeti." *www.importyei.com* (last accessed March 15, 2024).
[166] D&B Hoover's subscription login is accessible at *app.dnbhoovers.com*.

representatives if they were aware of any small OEMs during manufacturer interviews. DOE screened out companies that do not offer equipment covered by this rulemaking, do not meet the SBA's definition of a "small business," or are foreign-owned and operated.

For the October 2023 NOPR, DOE initially identified 83 OEMs that sell CRE in the United States. For this final rule, DOE refreshed its database of model listings to include the most up-to-date information on CRE models currently available on the U.S. market. Through its comprehensive review of its updated equipment database, other public sources, and stakeholder comments in response to the October 2023 NOPR, DOE identified 43 additional OEMs selling CRE in the United States (2 of which were identified as small, domestic businesses). DOE also determined 23 OEMs (7 of which were identified as small domestic businesses in the October 2023 NOPR) do not currently produce covered CRE for the U.S. market (*i.e.*, they do not manufacture CRE in-house). Therefore, of the 103 OEMs identified in this final rule, DOE determined that 20 companies qualify as small businesses and are not foreign-owned and operated.

5. Description of Reporting, Recordkeeping, and Other Compliance Requirements

Of the 20 small domestic CRE OEMs, 19 OEMs manufacture vertical equipment classes (*i.e*., vertical open ("VOP"), vertical closed transparent ("VCT"), or vertical closed solid ("VCS")); 7 OEMs manufacture semi-vertical open ("SVO") equipment classes (*i.e.*, medium temperature remote condensing ("RC"; "SVO.RC.M") or medium temperature self-contained ("SC"; "SVO.SC.M")); 6 OEMs manufacture service-over-counter ("SOC") equipment classes (*i.e.*, SOC.RC.M or SOC.SC.M); 8 OEMs manufacture horizontal equipment classes (*i.e.*, horizontal open ("HZO"), horizontal closed transparent ("HCT"), or horizontal closed solid ("HCS")); and 3 OEMs manufacture chef bases or griddle stands.

For the purposes of this FRFA, DOE assumed that the industry capital conversion costs would be evenly distributed across the OEMs that manufacture each equipment class to avoid underestimating the potential capital investments small manufacturers may incur as a result of the adopted standard. As discussed in section IV.J.2.c of this document, DOE scaled the industry capital conversion costs by the number of relevant OEMs offering models of the respective equipment class. For product conversion costs, DOE assumed all small businesses would choose to redesign or replace models that do not meet TSL 3 efficiency levels. DOE used unique basic model counts to scale the industry product conversion costs.

DOE expects manufacturers could meet TSL 3 without implementing occupancy sensors with dimming capability, triple-pane doors with krypton fill, or vacuum-insulated glass doors. At this level, only 2 self-contained equipment classes, HCT.SC.I and SOC.SC.M (together accounting for approximately 3 percent of transparent door CRE shipments), would likely incorporate improved door designs, which may necessitate new fixtures. For some self-contained equipment classes totaling approximately 50 percent of self-contained CRE shipments, manufacturers would likely have to incorporate variable-speed compressors into CRE designs. To incorporate variable-speed compressors, which could be larger than existing single-speed compressors, manufacturers may need new tools for the baseplate. Product conversion costs may be necessary to qualify, source, and test new high-efficiency components (*e.g.*, BLDC fan motors, variable-speed compressors).

Of the 19 small OEMs of vertical equipment classes, DOE expects 15 OEMs would incur some conversion costs to redesign models that do not currently meet the efficiency levels adopted in this final rule. The remaining 4 small OEMs would likely not incur conversion costs as a direct result of the standard as all their vertical CRE models currently meet or exceed TSL 3. Vertical equipment classes account for approximately 90 percent of industry shipments. Manufacturers will likely incorporate night curtains for all VOP equipment classes and BLDC condenser fan motors for nearly all vertical self-contained equipment classes. DOE further expects manufacturers to implement variable-speed compressors into some self-contained vertical equipment classes.

DOE expects all 7 small OEMs of semi-vertical equipment classes would incur some conversion costs to redesign models that do not currently meet the efficiency levels adopted in this final rule. Semi-vertical equipment classes account for approximately 2 percent of industry shipments in 2028. For SVO.SC.M, manufacturers will likely incorporate night curtains, BLDC condenser fan motors, and variable-speed compressors to meet TSL 3. For SVO.RC.M, manufacturers will likely incorporate night curtains to meet TSL 3.

Out of the 6 small OEMs of service-over-counter equipment classes, DOE expects 5 OEMs would incur some conversion costs to redesign models that do not currently meet the efficiency levels adopted in this final rule. The remaining small OEM would likely not incur conversion costs as a direct result of the standard as all their service-over-counter CRE models currently meet or exceed TSL 3. Service-over-counter equipment classes account for less than 1 percent of industry shipments. Manufacturers will likely incorporate BLDC evaporator and condenser fan motors, variable-speed compressors, and triple-pane doors with argon fill for SOC.SC.M to meet TSL 3. For SOC.RC.M, TSL 3 corresponds to the baseline efficiency level.

Out of the 8 small OEMs of horizontal equipment classes, DOE expects 7 OEMs would incur some conversion costs to redesign models that do not currently meet the efficiency levels adopted in this final rule. The remaining small OEM would likely not incur conversion costs as a direct result of the standard as all their horizontal CRE models currently meet or exceed TSL 3. Horizontal equipment classes account for approximately 6 percent of industry shipments. Manufacturers will likely implement BLDC condenser fan motors in both HCS equipment classes to meet TSL 3. Manufacturers will likely incorporate triple-pane doors with argon fill for HCT.SC.I. Manufacturers will likely incorporate BLDC condenser fan motors and variable-speed compressors for some HZO equipment classes to meet TSL 3. For HCT.SC.L, HCT.SC.M, HZO.RC.L, and HZO.RC.M, TSL 3 corresponds to the baseline efficiency levels.

DOE expects all 3 small OEMs offering chef base or griddle stand equipment to incur some conversion costs to redesign models that do not meet efficiency levels at TSL 3. Chef bases or griddle stands account for approximately 1 percent of industry shipments. Manufacturers would likely incorporate BLDC condenser fan motors and variable-speed compressors for CB.SC.M. None of the small businesses identified manufacture CB.SC.L models.

Based on annual revenue estimates from market research tools (*e.g.*, Dun & Bradstreet reports), the annual revenue of the small, domestic OEMs identified range from approximately $2.3 million to $307.9 million, with an average annual revenue of approximately $74.8 million. DOE estimates that conversion costs could range from $0.0 million to $12.9 million, with the average per OEM conversion costs of $1.5 million. The estimated total conversion costs as a percent of company revenue over the 4-year conversion period range from approximately 0.0 percent to 5.0 percent, with an average of 1.0 percent. See Table VI.1 for additional details.

Table VI.1 Potential Small Business Impacts (TSL 3)

Company	**Est. Conversion Costs** ($ millions)	**Est. Annual Revenue** ($ millions)	**Conversion Costs as a % of Conversion Period Revenue****	**Vertical***	**Semi-Vertical***	**Service-Over-Counter***	**Horizontal***	**Chef Base***
A	$0.5	$2.3	5.0%	X				
B	$0.8	$4.7	4.2%	X		X		
C	$12.9	$100.7	3.2%	X			X	X
D	$1.0	$9.0	2.9%	X	X	X		
E	$7.7	$131.1	1.5%	X	X	X	X	
F	$2.1	$110.3	0.5%	X	X	X	X	X
G	$1.5	$85.3	0.4%	X			X	
H	$1.6	$94.5	0.4%	X	X	X	X	
I	$0.4	$23.6	0.4%	X	X			
J	$0.1	$9.3	0.3%	X	X	X		
K	$0.1	$11.8	0.1%	X			X	
L	$0.1	$48.7	0.1%	X			X	
M	$0.2	$96.8	0.1%	X				
N	$0.2	$167.3	0.0%	X				X
O	$0.0	$20.0	0.0%	X	X			
P	$0.0	$27.5	0.0%	X				
Q	$0.0***	$4.0	0.0%				X	
R	$0.0***	$307.9	0.0%	X				
S	$0.0***	$217.0	0.0%	X				
T	$0.0***	$24.0	0.0%	X				

*The "X" indicates that the manufacturer offers CRE models of the respective equipment family.
**This column is calculated by dividing the estimated conversion costs by the revenue during the 4-year conversion period: (Est. Conversion Costs) ÷ [(Est. Annual Revenue) × 4 years].
***All models of directly analyzed CRE equipment classes meet or exceed the efficiency levels adopted in this final rule. Therefore, DOE does not expect these manufacturers would incur conversion costs as direct result of the final rule.

6. Significant Alternatives Considered and Steps Taken to Minimize Significant Economic Impacts on Small Entities

The discussion in the previous section analyzes impacts on small businesses that would result from the adopted standards, represented by TSL 3. In reviewing alternatives to the adopted standards, DOE examined energy conservation standards set at lower efficiency levels. While TSL 1 and TSL 2 would reduce the impacts on small business manufacturers, it would come at the expense of a reduction in energy savings.

TSL 1 achieves 78 percent lower energy savings compared to the energy savings at TSL 3. TSL 2 achieves 74 percent lower energy savings compared to the energy savings at TSL 3.

Establishing standards at TSL 3 balances the benefits of the energy savings at TSL 3 with the potential burdens placed on CRE manufacturers, including small business manufacturers. Accordingly, DOE is not adopting one of the other TSLs considered in the analysis, or the other policy alternatives examined as part of the regulatory impact analysis and included in chapter 17 of the final rule TSD.

Additionally, DOE notes that statutory provisions under EPCA state that should the Secretary determine that a 3-year period is inadequate, the Secretary may provide that the amended standard can apply to CRE manufactured on or after the date that is not later than 5 years after the date on which the final rule is published in the *Federal Register*. (See 42 U.S.C. 6313(c)(6)(C)(ii)) Pursuant to this EPCA provision, 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. DOE has determined that a longer compliance period for CRE is warranted based on stakeholder comments and DOE's assessment of the overlapping Federal refrigerant regulations and recent changes to UL safety standards for CRE. DOE understands that the longer compliance period will help mitigate cumulative regulatory burden by allowing manufacturers of CRE, including small businesses, more flexibility to spread investments across 4 years instead of 3 years. Manufacturers, including small businesses, will also have more time to recoup any investments made to redesign CRE models in compliance with the October 2023 EPA Final Rule as compared to a 3-year compliance period. 88 FR 73098.

Additional compliance flexibilities may be available through other means. Manufacturers subject to DOE's energy efficiency standards may apply to DOE's Office of Hearings and Appeals for exception relief under certain circumstances. Manufacturers should refer to 10 CFR part 1003 for additional details.

C. Review Under the Paperwork Reduction Act

Manufacturers of CRE must certify to DOE that their products comply with any applicable energy conservation standards. In certifying compliance, manufacturers must test their products according to the DOE test procedures for CRE, including any amendments adopted for those test procedures. DOE has established regulations for the certification and recordkeeping requirements for all covered consumer products and commercial equipment, including CRE. (*See generally* 10 CFR part 429). The collection-of-information requirement for the certification and recordkeeping is subject to review and approval by OMB under the Paperwork Reduction Act ("PRA"). This requirement has been approved by

OMB under OMB control number 1910-1400. Public reporting burden for the certification is estimated to average 35 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information.

Notwithstanding any other provision of the law, no person is required to respond to, nor shall any person be subject to a penalty for failure to comply with, a collection of information subject to the requirements of the PRA, unless that collection of information displays a currently valid OMB Control Number.

D. Review Under the National Environmental Policy Act of 1969

Pursuant to the National Environmental Policy Act of 1969 ("NEPA"), DOE has analyzed this rule in accordance with NEPA and DOE's NEPA implementing regulations (10 CFR part 1021). DOE has determined that this rule qualifies for categorical exclusion under 10 CFR part 1021, subpart D, appendix B5.1 because it is a rulemaking that establishes energy conservation standards for consumer products or industrial equipment, none of the exceptions identified in B5.1(b) apply, no extraordinary circumstances exist that require further environmental analysis, and it meets the requirements for application of a categorical exclusion. *See* 10 CFR 1021.410. Therefore, DOE has determined that promulgation of this rule is not a major Federal action significantly affecting the quality of the human environment within the meaning of NEPA, and does not require an environmental assessment or an environmental impact statement.

E. Review Under Executive Order 13132

E.O. 13132, "Federalism," 64 FR 43255 (Aug. 10, 1999), imposes certain requirements on Federal agencies formulating and implementing policies or regulations that preempt State law or that have federalism implications. The Executive order requires agencies to examine the constitutional and statutory authority supporting any action that would limit the policymaking discretion of the States and to carefully assess the necessity for such actions. The Executive order also requires agencies to have an accountable process to ensure meaningful and timely input by State and local officials in the development of regulatory policies that have federalism implications. On March 14, 2000, DOE published a statement of policy describing the intergovernmental consultation process it will follow in the development of such regulations. 65 FR 13735. DOE has examined this rule and has determined that it would not have a substantial direct effect on the States, on the relationship between the national government and the States, or on the distribution of power and responsibilities among the various levels of government. EPCA governs and prescribes Federal preemption of State regulations as to energy conservation for the equipment that are the subject of this final rule. States can petition DOE for exemption from such preemption to the extent, and based on criteria, set forth in EPCA. (42 U.S.C. 6316(e)(2)–(3); 42 U.S.C. 6297. Therefore, no further action is required by Executive Order 13132.

F. Review Under Executive Order 12988

With respect to the review of existing regulations and the promulgation of new regulations, section 3(a) of E.O. 12988, "Civil Justice Reform," imposes on Federal agencies the general duty to adhere to the following requirements: (1) eliminate drafting errors and ambiguity, (2) write regulations to minimize litigation, (3) provide a clear legal standard for affected conduct rather than a general standard, and (4) promote simplification and burden reduction. 61 FR 4729 (February 7, 1996). Regarding the review required by section 3(a), section 3(b) of E.O. 12988 specifically requires that Executive agencies make every reasonable effort to ensure that the regulation: (1) clearly specifies the preemptive effect, if any; (2) clearly specifies any effect on existing Federal law or regulation; (3) provides a clear legal standard for affected conduct while promoting simplification and burden reduction; (4) specifies the retroactive effect, if any; (5) adequately defines key terms; and (6) addresses other important issues affecting clarity and general draftsmanship under any guidelines issued by the Attorney General. Section 3(c) of E.O. 12988 requires Executive agencies to review regulations in light of applicable standards in section 3(a) and section 3(b) to determine whether they are met or it is unreasonable to meet one or more of them. DOE has completed the required review and determined that, to the extent permitted by law, this final rule meets the relevant standards of E.O. 12988.

G. Review Under the Unfunded Mandates Reform Act of 1995

Title II of the Unfunded Mandates Reform Act of 1995 ("UMRA") requires each Federal agency to assess the effects of Federal regulatory actions on State, local, and Tribal governments and the private sector. Pub. L. 104-4, sec. 201 (codified at 2 U.S.C. 1531). For a regulatory action likely to result in a rule that may cause the expenditure by State, local, and Tribal governments, in the aggregate, or by the private sector of $100 million or more in any one year (adjusted annually for inflation), section 202 of UMRA requires a Federal agency to publish a written statement that estimates the resulting costs, benefits, and other effects on the national economy. (2 U.S.C. 1532(a), (b)) UMRA also requires a Federal agency to develop an effective process to permit timely input by elected officers of State, local, and Tribal governments on a "significant intergovernmental mandate," and requires an agency plan for giving notice and opportunity for timely input to potentially affected small governments before establishing any requirements that might significantly or uniquely affect them. On March 18, 1997, DOE published a statement of policy on its process for intergovernmental consultation under UMRA. 62 FR 12820. DOE's policy statement is also available at *www.energy.gov/sites/prod/files/gcprod/documents/umra_97.pdf.*

DOE has concluded that this final rule may require expenditures of $100 million or more in any one year by the private sector. Such expenditures may include: (1) investment in research and development and in capital expenditures by CRE manufacturers in the years between the final rule and the compliance date for the new standards; and (2) incremental additional expenditures by consumers to purchase higher-efficiency CRE, starting at the compliance date for the applicable standard.

Section 202 of UMRA authorizes a Federal agency to respond to the content requirements of UMRA in any other statement or analysis that accompanies the final rule. (2 U.S.C. 1532(c)) The content requirements of section 202(b) of UMRA relevant to a private sector mandate substantially overlap the economic analysis requirements that apply under section 325(o) of EPCA and Executive Order 12866. The **SUPPLEMENTARY INFORMATION** section of this document and the TSD for this final rule respond to those requirements.

Under section 205 of UMRA, DOE is obligated to identify and consider a reasonable number of regulatory alternatives before promulgating a rule for which a written statement under section 202 is required. (2 U.S.C. 1535(a)) DOE is required to select from those alternatives the most cost-effective and least burdensome alternative that achieves the objectives of the rule unless DOE publishes an explanation for doing otherwise, or the selection of such an alternative is inconsistent with law. As required by 42 U.S.C. 6295(m) or a product-specific directive in 6295, and 42 U.S.C. 6316(e)(1), and 6313(c)(6), this final rule establishes new and amended energy conservation standards for CRE that are designed to achieve the maximum improvement in energy efficiency that DOE has determined to be both technologically feasible and economically justified, as required by 6316(e)(1), 6295(o)(2)(A), and 6295(o)(3)(B). A full discussion of the alternatives considered by DOE is presented in chapter 17 of the TSD for this final rule.

H. Review Under the Treasury and General Government Appropriations Act, 1999

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. No. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any proposed rule or policy that may affect family well-being. When developing a Family Policymaking Assessment, agencies must assess whether: (1) the action strengthens or erodes the stability or safety of the family and, particularly, the marital commitment; (2) the action strengthens or erodes the authority and rights of parents in the education, nurture, and supervision of their children; (3) the action helps the family perform its functions, or substitutes governmental activity for the function; (4) the action increases or decreases disposable income or poverty of families and children; (5) the proposed benefits of the action justify the financial impact on the family; (6) the action may be carried out by State or local government or by the family; and whether (7) the action establishes an implicit or explicit policy concerning the relationship between the behavior and personal responsibility of youth, and the norms of society. In evaluating the above factors, DOE has concluded that it is not necessary to prepare a Family Policymaking Assessment as none of the above factors are implicated. Further, this proposed determination would not have any financial impact on families nor any impact on the autonomy or integrity of the family as an institution.

Section 654 of the Treasury and General Government Appropriations Act, 1999 (Pub. L. No. 105-277) requires Federal agencies to issue a Family Policymaking Assessment for any proposed rule or policy that may affect family well-being. Although this final rule would not have any impact on the autonomy or integrity of the family as an institution as defined, this final rule could impact a family's well-being. When developing a Family Policymaking Assessment, agencies must assess whether: (1) the action strengthens or erodes the stability or safety of the family and, particularly, the marital commitment; (2) the action strengthens or erodes the authority and rights of parents in the education, nurture, and supervision of their children; (3) the action helps the family perform its functions, or substitutes governmental activity for the function; (4) the action increases or decreases disposable income or poverty of families and children; (5) the proposed benefits of the action justify the financial impact on the family; (6) the action may be carried out by State or local government or by the family; and whether (7) the action establishes an implicit or explicit policy concerning the relationship between the behavior and personal responsibility of youth, and the norms of society.

DOE has considered how the benefits of this final rule compare to the possible financial impact on a family (the only factor listed that is relevant to this rule). As part of its rulemaking process, DOE must determine whether the energy conservation standards enacted in this final rule are economically justified. As discussed in section V.C.1 of this document, DOE has determined that the standards enacted in this final rule are economically justified because the benefits to consumers would far outweigh the costs to manufacturers. Customers will also see LCC savings as a result of this final rule. Moreover, as discussed further in section V.B.1 of this document, DOE has determined that for small businesses, average LCC savings and PBP at the considered efficiency levels are similar compared to those for all purchasers. Further, the standards will also result in climate and health benefits for all businesses.

I. Review Under Executive Order 12630

Pursuant to E.O. 12630, "Governmental Actions and Interference with Constitutionally Protected Property Rights," 53 FR 8859 (March 18, 1988), DOE has determined that this rule would not result in any takings that might require compensation under the Fifth Amendment to the U.S. Constitution.

J. Review Under the Treasury and General Government Appropriations Act, 2001

Section 515 of the Treasury and General Government Appropriations Act, 2001 (44 U.S.C. 3516, note) provides for Federal agencies to review most disseminations of information to the public under information quality guidelines established by each agency pursuant to general guidelines issued by OMB. OMB's guidelines were published at 67 FR 8452 (February 22, 2002), and DOE's guidelines were published at 67 FR 62446 (Oct. 7, 2002). Pursuant to OMB Memorandum M-19-15, Improving Implementation of the Information Quality Act (April 24, 2019), DOE published updated guidelines which are available at *www.energy.gov/sites/prod/files/2019/12/f70/DOE%20Final%20Updated%20IQA%20Guidelines%20Dec%202019.pdf*. DOE has reviewed this final rule under the OMB and DOE guidelines and has concluded that it is consistent with applicable policies in those guidelines.

K. Review Under Executive Order 13211

E.O. 13211, "Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution, or Use," 66 FR 28355 (May 22, 2001), requires Federal agencies to prepare and submit to OIRA at OMB, a Statement of Energy Effects for any significant energy action. A "significant energy action" is defined as any action by an agency that promulgates or is expected to lead to promulgation of a final rule, and that: (1) is a significant regulatory action under Executive Order 12866, or any successor order, and is likely to have a significant adverse effect on the supply, distribution, or use of energy; or (2) is designated by the Administrator of OIRA as a significant energy action. For any significant energy action, the agency must give a detailed statement of any adverse effects on energy supply, distribution, or use should the proposal be implemented, and of reasonable alternatives to the action and their expected benefits on energy supply, distribution, and use.

DOE has concluded that this regulatory action, which sets forth new and amended energy conservation standards for CRE, is not a significant energy action because the standards are not likely to have a significant adverse effect on the supply, distribution, or use of energy, nor has it been designated as such by the Administrator at OIRA. Accordingly, DOE has not prepared a Statement of Energy Effects on this final rule.

L. Information Quality

On December 16, 2004, OMB, in consultation with the Office of Science and Technology Policy ("OSTP"), issued its Final Information Quality Bulletin for Peer Review ("the Bulletin"). 70 FR 2664 (Jan. 14, 2005). The Bulletin establishes that certain scientific information shall be peer reviewed by qualified specialists before it is disseminated by the Federal Government, including influential scientific information related to agency regulatory actions. The purpose of the Bulletin is to enhance the quality and credibility of the Government's scientific information. Under the Bulletin, the energy conservation standards rulemaking analyses are "influential scientific information," which the Bulletin defines as "scientific information the agency reasonably can determine will have, or does have, a clear and substantial impact on important public policies or private sector decisions." 70 FR 2664, 2667.

In response to OMB's Bulletin, DOE conducted formal peer reviews of the energy conservation standards development process and the analyses that are typically used and prepared a report describing that peer review.[167] Generation of this report involved a rigorous, formal, and documented evaluation using objective criteria and qualified and independent reviewers to make a judgment as to the technical/scientific/business merit, the actual or anticipated results, and the productivity and management effectiveness of programs and/or projects. Because available data, models, and technological understanding have changed since 2007, DOE has engaged with the National Academy of Sciences to review

[167] The 2007 "Energy Conservation Standards Rulemaking Peer Review Report" is available at *energy.gov/eere/buildings/downloads/energy-conservation-standards-rulemaking-peer-review-report-0* (last accessed April 15, 2024).

DOE's analytical methodologies to ascertain whether modifications are needed to improve DOE's analyses. DOE is in the process of evaluating the resulting report.[168]

M. Congressional Notification

As required by 5 U.S.C. 801, DOE will report to Congress on the promulgation of this rule prior to its effective date. The Office of Information and Regulatory Affairs has determined that this rule meets the criteria set forth in 5 U.S.C. 804(2).

VII. Approval of the Office of the Secretary

The Secretary of Energy has approved publication of this final rule.

List of Subjects in 10 CFR Part 431

Administrative practice and procedure, Confidential business information, Energy conservation test procedures, Incorporation by reference, and Reporting and recordkeeping requirements.

Signing Authority

This document of the Department of Energy was signed on December 20, 2024, by Jeffrey Marootian, Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy, pursuant to delegated authority from the Secretary of Energy. That document with

[168] The report is available at *www.nationalacademies.org/our-work/review-of-methods-for-setting-building-and-equipment-performance-standards*.

the original signature and date is maintained by DOE. For administrative purposes only, and in compliance with requirements of the Office of the Federal Register, the undersigned DOE Federal Register Liaison Officer has been authorized to sign and submit the document in electronic format for publication, as an official document of the Department of Energy. This administrative process in no way alters the legal effect of this document upon publication in the *Federal Register*.

Signed in Washington, DC, on December 20, 2024.

Jeffrey M. Marootian
Digitally signed by Jeffrey M. Marootian
Date: 2024.12.20 15:59:34 -05'00'

Jeffrey Marootian
Principal Deputy Assistant Secretary for Energy Efficiency and Renewable Energy
U.S. Department of Energy

For the reasons set forth in the preamble, DOE amends part 431 of chapter II, subchapter D, of title 10 of the Code of Federal Regulations, as set forth below:

PART 431 - ENERGY EFFICIENCY PROGRAM FOR CERTAIN COMMERCIAL AND INDUSTRIAL EQUIPMENT

1. The authority citation for part 431 continues to read as follows:

Authority: 42 U.S.C. 6291-6317; 28 U.S.C. 2461 note.

2. Amend § 431.62 by:

a. Adding in alphabetical order definitions for "Cold-wall evaporator," "Drawer unit," and "Forced-air evaporator;"

b. Revising the definition of "Ice-cream freezer;"

c. Adding in alphabetical order a definition for "Pass-through doors;"

d. Revising the definition of "Rating temperature;" and

e. Adding in alphabetical order definitions for "Roll-in door," "Roll-through doors," and "Sliding door."

The additions and revisions read as follows.

§431.62 Definitions concerning commercial refrigerators, freezers, and refrigerator-freezers.

* * * * *

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.

* * * * *

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

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.

* * * * *

Ice-cream freezer means:

(1) Prior to [Date 4 years after Date of Publication in the Federal Register], a commercial freezer that is capable of an operating temperature at or below −5.0 °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) On or after [Date 4 years after Date of Publication in the Federal Register], a commercial freezer that is capable of an operating temperature at or below −13.0 °F and that the manufacturer designs, markets, or intends specifically for the storing, displaying, or dispensing of ice cream or other frozen desserts.

* * * * *

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

* * * * *

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 this subpart, as applicable.

*   *   *   *   *

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.

*   *   *   *   *

3. Revise §431.66 to read as follows:

§431.66 Energy conservation standards and their effective dates.

(a) Each commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit designed for holding temperature applications and with solid or transparent doors; commercial refrigerator with a self-contained condensing unit designed for pull-down temperature applications and with transparent doors; commercial refrigerator, freezer, and refrigerator-freezer with a self-contained condensing unit and without doors; commercial refrigerator, freezer, and refrigerator-freezer with a remote condensing unit; and commercial ice-cream freezer manufactured on or after March 27, 2017, and before [Date 4 Years after Date of Publication in the Federal Register], shall have a daily energy consumption (in kilowatt-hours per day or "kWh/day") that does not exceed the levels specified:

(1) For equipment other than hybrid equipment, refrigerator/freezers, or wedge cases:

Table 1 to paragraph (a)(1) – Maximum Daily Energy Consumption Standards

Equipment category	Condensing unit configuration	Equipment family	Rating temp. °F	Operating temp. °F	Equipment class designation*	Maximum daily energy consumption** (kWh/day)
Remote Condensing Commercial Refrigerators and Commercial Freezers	Remote (RC)	Vertical Open (VOP)	38 (M)	≥ 32	VOP.RC.M	0.64 x TDA + 4.07
			0 (L)	< 32	VOP.RC.L	2.2 x TDA + 6.85
		Semivertical Open (SVO)	38 (M)	≥ 32	SVO.RC.M	0.66 x TDA + 3.18
			0 (L)	< 32	SVO.RC.L	2.2 x TDA + 6.85
		Horizontal Open (HZO)	38 (M)	≥ 32	HZO.RC.M	0.35 x TDA + 2.88
			0 (L)	< 32	HZO.RC.L	0.55 x TDA + 6.88
		Vertical Closed Transparent (VCT)	38 (M)	≥ 32	VCT.RC.M	0.15 x TDA + 1.95
			0 (L)	< 32	VCT.RC.L	0.49 x TDA + 2.61
		Horizontal Closed Transparent (HCT)	38 (M)	≥ 32	HCT.RC.M	0.16 x TDA + 0.13
			0 (L)	< 32	HCT.RC.L	0.34 x TDA + 0.26
		Vertical Closed Solid (VCS)	38 (M)	≥ 32	VCS.RC.M	0.1 x V + 0.26
			0 (L)	< 32	VCS.RC.L	0.21 x V + 0.54
		Horizontal Closed Solid (HCS)	38 (M)	≥ 32	HCS.RC.M	0.1 x V + 0.26
			0 (L)	< 32	HCS.RC.L	0.21 x V + 0.54
		Service Over Counter (SOC)	38 (M)	≥ 32	SOC.RC.M	0.44 x TDA + 0.11
			0 (L)	< 32	SOC.RC.L	0.93 x TDA + 0.22

Self-Contained Commercial Refrigerators and Commercial Freezers Without Doors	Self-Contained (SC)	Vertical Open (VOP)	38 (M)	≥ 32	VOP.SC.M	1.69 x TDA + 4.71
			0 (L)	< 32	VOP.SC.L	4.25 x TDA + 11.82
		Semivertical Open (SVO)	38 (M)	≥ 32	SVO.SC.M	1.7 x TDA + 4.59
			0 (L)	< 32	SVO.SC.L	4.26 x TDA + 11.51
		Horizontal Open (HZO)	38 (M)	≥ 32	HZO.SC.M	0.72 x TDA + 5.55
			0 (L)	< 32	HZO.SC.L	1.9 x TDA + 7.08
Self-Contained Commercial Refrigerators and Commercial Freezers With Doors	Self-Contained (SC)	Vertical Closed Transparent (VCT)	38 (M)	≥ 32	VCT.SC.M	0.1 x V + 0.86
			0 (L)	< 32	VCT.SC.L	0.29 x V + 2.95
		Vertical Closed Solid (VCS)	38 (M)	≥ 32	VCS.SC.M	0.05 x V + 1.36
			0 (L)	< 32	VCS.SC.L	0.22 x V + 1.38
		Horizontal Closed Transparent (HCT)	38 (M)	≥ 32	HCT.SC.M	0.06 x V + 0.37
			0 (L)	< 32	HCT.SC.L	0.08 x V + 1.23
		Horizontal Closed Solid (HCS)	38 (M)	≥ 32	HCS.SC.M	0.05 x V + 0.91
			0 (L)	< 32	HCS.SC.L	0.06 x V + 1.12
		Service Over Counter (SOC)	38 (M)	≥ 32	SOC.SC.M	0.52 x TDA + 1
			0 (L)	< 32	SOC.SC.L	1.1 x TDA + 2.1
Self-Contained Commercial Refrigerators with Transparent Doors for Pull-Down Temperature Applications	Self-Contained (SC)	Pull-Down (PD)	38 (M)	≥ 32	PD.SC.M	0.11 x V + 0.81
Commercial Ice-Cream Freezers	Remote (RC)	Vertical Open (VOP)	-15 (I)	≤ -5	VOP.RC.I	2.79 x TDA + 8.7
		Semivertical Open (SVO)			SVO.RC.I	2.79 x TDA + 8.7

		Horizontal Open (HZO)			HZO.RC.I	0.7 x TDA + 8.74
		Vertical Closed Transparent (VCT)			VCT.RC.I	0.58 x TDA + 3.05
		Horizontal Closed Transparent (HCT)			HCT.RC.I	0.4 x TDA + 0.31
		Vertical Closed Solid (VCS)			VCS.RC.I	0.25 x V + 0.63
		Horizontal Closed Solid (HCS)			HCS.RC.I	0.25 x V + 0.63
		Service Over Counter (SOC)			SOC.RC.I	1.09 x TDA + 0.26
	Self-Contained (SC)	Vertical Open (VOP)			VOP.SC.I	5.4 x TDA + 15.02
		Semivertical Open (SVO)			SVO.SC.I	5.41 x TDA + 14.63
		Horizontal Open (HZO)			HZO.SC.I	2.42 x TDA + 9
		Vertical Closed Transparent (VCT)			VCT.SC.I	0.62 x TDA + 3.29
		Horizontal Closed Transparent (HCT)			HCT.SC.I	0.56 x TDA + 0.43
		Vertical Closed Solid (VCS)			VCS.SC.I	0.34 x V + 0.88
		Horizontal Closed Solid (HCS)			HCS.SC.I	0.34 x V + 0.88
		Service Over Counter (SOC)			SOC.SC.I	1.53 x TDA + 0.36

* The meaning of the letters in this column is indicated in the columns to the left.
** “V” is the volume, expressed in ft^3, as determined in appendix B to this subpart. “TDA” is the total display area, expressed in ft^2, as determined in appendix B to this subpart.

(2) For commercial refrigeration equipment with two or more compartments (*i.e.,* hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers), the maximum daily energy consumption (MDEC) for each model shall be the sum of the MDEC values for all of its compartments. For each compartment, measure the TDA or volume of that compartment, and determine the appropriate equipment class based on that compartment's equipment family, condensing unit configuration, and designed operating temperature. The MDEC limit for each compartment shall be the calculated value obtained by entering that compartment's TDA or volume into the standard equation in paragraph (a)(1) of this section for that compartment's equipment class. Measure the calculated daily energy consumption (CDEC) or total daily energy consumption (TDEC) for the entire case:

(i) For remote condensing commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, where two or more independent condensing units each separately cool only one compartment, measure the total refrigeration load of each compartment separately according to AHRI Standard 1200 (I-P)-2010 test procedure (incorporated by reference, see § 431.63). Calculate compressor energy consumption (CEC) for each compartment using Table 1 in AHRI Standard 1200 (I-P)-2010 using the saturated evaporator temperature for that compartment. The CDEC for the entire case shall be the sum of the CEC for each compartment, fan energy consumption (FEC), lighting energy consumption (LEC), anti-condensate energy consumption (AEC), defrost energy consumption (DEC), and condensate evaporator pan energy consumption (PEC) (as measured in AHRI Standard 1200 (I-P)-2010).

(ii) For remote condensing commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, where two or more compartments are cooled collectively by one condensing unit, measure the total refrigeration load of the entire case according to the AHRI Standard 1200 (I-P)-2010 test procedure (incorporated by reference, see § 431.63). Calculate a weighted saturated evaporator temperature for the entire case by:

(A) Multiplying the saturated evaporator temperature of each compartment by the volume of that compartment (as measured in AHRI Standard 1200 (I-P)-2010),

(B) Summing the resulting values for all compartments; and

(C) Dividing the resulting total by the total volume of all compartments.

Calculate the CEC for the entire case using Table 1 in AHRI Standard 1200 (I-P)-2010 (incorporated by reference, see § 431.63), using the total refrigeration load and the weighted average saturated evaporator temperature. The CDEC for the entire case shall be the sum of the CEC, FEC, LEC, AEC, DEC, and PEC.

(iii) For self-contained commercial hybrid refrigerators, hybrid freezers, hybrid refrigerator-freezers, and non-hybrid refrigerator-freezers, measure the TDEC for the entire case according to the AHRI Standard 1200 (I-P)-2010 test procedure (incorporated by reference, see § 431.63).

(3) For remote condensing and self-contained wedge cases, measure the CDEC or TDEC according to the AHRI Standard 1200 (I-P)-2010 test procedure (incorporated by reference, see § 431.63). For wedge cases in equipment classes for which a volume metric is used, the MDEC shall be the amount derived from the appropriate standards equation in paragraph (a)(1) of this section. For wedge cases of equipment classes for which a TDA metric is used, the MDEC for each model shall be the amount derived by incorporating into the standards equation in paragraph (a)(1) of this section for the equipment class a value for the TDA that is the product of:

(i) The vertical height of the air-curtain (or glass in a transparent door) and

(ii) The largest overall width of the case, when viewed from the front.

(b) Each commercial refrigerator, freezer, and refrigerator-freezer, except as specified in paragraph (c) of this section, manufactured on or after [Date 4 years after Date of Publication in the Federal Register], shall have a daily energy consumption (in kilowatt-hours per day or “kWh/day”), when measured in accordance with the DOE test procedure at appendix B to this subpart, that does not exceed the following:

(1) For commercial refrigerators, freezers, and refrigerator-freezers other than commercial hybrids or commercial refrigerator-freezers:

Table 2 to paragraph (b)(1) – Maximum Daily Energy Consumption Standards for Equipment Connected to Remote Condensing Units

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)	55.0 (H)	> 40.0	VOP.RC.H	0.551 × TDA + 3.506
		38.0 (M)	≤ 40.0 and ≥ 32.0	VOP.RC.M	0.591 × TDA + 3.758
		0.0 (L)	< 32.0	VOP.RC.L	2.079 × TDA + 6.472
		-15.0 (I)	≤ -13.0	VOP.RC.I	2.637 × TDA + 8.222
	Semivertical Open (SVO)	55.0 (H)	> 40.0	SVO.RC.H	0.572 × TDA + 2.756
		38.0 (M)	≤ 40.0 and ≥ 32.0	SVO.RC.M	0.611 × TDA + 2.944
		0.0 (L)	< 32.0	SVO.RC.L	2.079 × TDA + 6.473
		-15.0 (I)	≤ -13.0	SVO.RC.I	2.637 × TDA + 8.222
	Horizontal Open (HZO)	55.0 (H)	> 40.0	HZO.RC.H	0.350 × TDA + 2.880
		38.0 (M)	≤ 40.0 and ≥ 32.0	HZO.RC.M	0.350 × TDA + 2.880
		0.0 (L)	< 32.0	HZO.RC.L	0.550 × TDA + 6.880
		-15.0 (I)	≤ -13.0	HZO.RC.I	0.700 × TDA + 8.740
	Vertical Closed Transparent (VCT)	55.0 (H)	> 40.0	VCT.RC.H	0.150 × TDA + 1.950
		38.0 (M)	≤ 40.0 and ≥ 32.0	VCT.RC.M	0.150 × TDA + 1.950
		0.0 (L)	< 32.0	VCT.RC.L	0.490 × TDA + 2.610
		-15.0 (I)	≤ -13.0	VCT.RC.I	0.580 × TDA + 3.050
	Horizontal Closed	38.0 (M)	≥ 32.0	HCT.RC.M	0.160 × TDA + 0.130

	Transparent (HCT)	0.0 (L)	< 32.0	HCT.RC.L	0.340 × TDA + 0.260
		-15.0 (I)	≤ -13.0	HCT.RC.I	0.356 × TDA + 0.276
	Vertical Closed Solid (VCS)	55.0 (H)	> 40.0	VCS.RC.H	0.100 × V + 0.260
		38.0 (M)	≤ 40.0 and ≥ 32.0	VCS.RC.M	0.100 × V + 0.260
		0.0 (L)	< 32.0	VCS.RC.L	0.210 × V + 0.540
		-15.0 (I)	≤ -13.0	VCS.RC.I	0.250 × V + 0.630
	Horizontal Closed Solid (HCS)	38.0 (M)	≥ 32.0	HCS.RC.M	0.100 × V + 0.260
		0.0 (L)	< 32.0	HCS.RC.L	0.210 × V + 0.540
		-15.0 (I)	≤ -13.0	HCS.RC.I	0.250 × V + 0.630
	Service Over Counter (SOC)	55.0 (H)	> 40.0	SOC.RC.H	0.440 × TDA + 0.110
		38.0 (M)	≤ 40.0 and ≥ 32.0	SOC.RC.M	0.440 × TDA + 0.110
		0.0 (L)	< 32.0	SOC.RC.L	0.930 × TDA + 0.220
		-15.0 (I)	≤ -13.0	SOC.RC.I	0.970 × TDA + 0.231
	Chef Base (CB)	38.0 (M)	≥ 32.0	CB.RC.M	0.050 × V + 0.686
		0.0 (L)	< 32.0	CB.RC.L	0.194 × V + 1.693

* The meaning of the letters in this column is indicated in the columns to the left.
** "V" is the volume, expressed in ft^3, as determined in appendix B to this subpart. "TDA" is the total display area, expressed in ft^2, as determined in appendix B to this subpart.

Table 3 to paragraph (b)(1) – Maximum Daily Energy Consumption Standards for Equipment Connected to Self-Contained Units

Condensing Unit Configuration	Equipment Family	Rating Temperature (°F)	Operating Temperature (°F)	Capacity Range	Equipment Class Designation*	Maximum Daily Energy Consumption** (kWh/day)
		55.0 (H)	> 40.0	All TDAs	VOP.SC.H	0.890 × TDA + 2.480

Self-Contained (SC)	Vertical Open (VOP)	38.0 (M)	≤ 40.0 and ≥ 32.0	TDA ≤ 17 ft^2	VOP.SC.M (≤ 17)	1.230 × TDA + 3.428
				TDA > 17 ft^2	VOP.SC.M (> 17)	1.69 × TDA + 4.71
		0.0 (L)	< 32.0	All TDAs	VOP.SC.L	3.092 × TDA + 8.598
		-15.0 (I)	≤ -13.0		VOP.SC.I	3.928 × TDA + 10.926
	Semivertical Open (SVO)	55.0 (H)	> 40.0	All TDAs	SVO.SC.H	1.045 × TDA + 2.822
		38.0 (M)	≤ 40.0 and ≥ 32.0	TDA ≤ 15 ft^2	SVO.SC.M (≤ 15)	1.207 × TDA + 3.258
				TDA > 15 ft^2	SVO.SC.M (> 15)	1.7 × TDA + 4.59
		0.0 (L)	< 32.0	All TDAs	SVO.SC.L	3.024 × TDA + 8.169
		-15.0 (I)	≤ -13.0		SVO.SC.I	3.840 × TDA + 10.384
	Horizontal Open (HZO)	55.0 (H)	> 40.0	All TDAs	HZO.SC.H	0.546 × TDA + 4.211
		38.0 (M)	≤ 40.0 and ≥ 32.0		HZO.SC.M	0.532 × TDA + 4.100
		0.0 (L)	< 32.0	TDA ≤ 35 ft^2	HZO.SC.L (≤ 35)	1.490 × TDA + 5.554
				TDA > 35 ft^2	HZO.SC.L (> 35)	1.9 × TDA + 7.08
		-15.0 (I)	≤ -13.0	All TDAs	HZO.SC.I	1.900 × TDA + 7.065
	Vertical Closed Transparent (VCT)	55.0 (H)	> 40.0	All TDAs	VCT.SC.H	0.047 × V + 0.493
		38.0 (M)	≤ 40.0 and ≥ 32.0	V ≤ 100 ft^3	VCT.SC.M (≤ 100)	0.073 × V + 0.630
					VCT.SC.M (≤ 100) with Feature***	0.078 × V + 0.674
				V > 100 ft^3	VCT.SC.M (> 100)	0.1 × V + 0.86
		0.0 (L)	< 32.0	V ≤ 70 ft^3	VCT.SC.L (≤ 70)	0.233 × V + 2.374
					VCT.SC.L (≤ 70) with Feature***	0.249 × V + 2.540
				V > 70 ft^3	VCT.SC.L (> 70)	0.29 × V + 2.95
		-15.0 (I)	≤ -13.0	All Volumes	VCT.SC.I	0.620 × TDA + 3.290

	Vertical Closed Solid (VCS)	55.0 (H)	> 40.0	All Volumes	VCS.SC.H	0.021 × V + 0.793
		38.0 (M)	≤ 40.0 and ≥ 32.0	All Volumes	VCS.SC.M	0.038 × V + 1.039
					VCS.SC.M with Feature***	0.041 × V + 1.112
		0.0 (L)	< 32.0	V ≤ 100 ft^3	VCS.SC.L (≤ 100)	0.169 × V + 1.059
					VCS.SC.L (≤ 100) with Feature***	0.181 × V + 1.133
				V > 100 ft^3	VCS.SC.L (> 100)	0.22 × V + 1.38
		-15.0 (I)	≤ -13.0	All Volumes	VCS.SC.I	0.264 × V + 0.683
	Horizontal Closed Transparent (HCT)	38.0 (M)	≥ 32.0	All Volumes	HCT.SC.M	0.060 × V + 0.370
		0.0 (L)	< 32.0		HCT.SC.L	0.080 × V + 1.230
		-15.0 (I)	≤ -13.0		HCT.SC.I	0.498 × TDA + 0.383
	Horizontal Closed Solid (HCS)	38.0 (M)	≥32.0	All Volumes	HCS.SC.M	0.037 × V + 0.675
		0.0 (L)	<32.0		HCS.SC.L	0.055 × V + 1.033
					HCS.SC.L with Feature***	0.059 × V + 1.105
		-15.0 (I)	≤ -13.0		HCS.SC.I	0.313 × V + 0.811
	Service Over Counter (SOC)	55.0 (H)	> 40.0	All TDAs	SOC.SC.H	0.304 × TDA + 0.584
		38.0 (M)	≤ 40.0 and ≥ 32.0	TDA ≤ 40 ft^2	SOC.SC.M (≤ 40)	0.356 × TDA + 0.685
				TDA > 40 ft^2	SOC.SC.M (> 40)	0.52 × TDA + 1
		0.0 (L)	<32.0	All TDAs	SOC.SC.L	1.100 × TDA + 2.100
		-15.0 (I)	≤ -13.0		SOC.SC.I	1.530 × TDA + 0.360
	Chef Base (CB)	38.0 (M)	≥ 32.0	All Volumes	CB.SC.M	0.081 × V + 1.117
		0.0 (L)	< 32.0		CB.SC.L	0.297 × V + 2.591

	Pull-Down (PD)	38.0 (M)	≥32.0		PD.SC.M	0.11 × V + 0.81

* The meaning of the letters in this column is indicated in the columns to the left.
** "V" is the volume, expressed in ft^3, as determined in appendix B to this subpart. "TDA" is the total display area, expressed in ft^2, as determined in appendix B to this subpart.
*** For equipment classes designated "with Feature," refer to Table 4 to this paragraph for the list of qualifying features applicable to each class.

Table 4 to paragraph (b)(1) – Qualifying Features for Equipment Classes Designated "with Feature"

Equipment Class	Qualifying 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 Drawer units
VCS.SC.L (≤ 100)	Pass-through doors Roll-in doors Roll-through doors Drawer units
HCS.SC.L	Forced air evaporator

(2) For commercial hybrids and commercial refrigerator-freezers, for each compartment, measure the TDA or volume of that compartment. The MDEC limit for each compartment shall be the calculated value obtained by entering that compartment's TDA or volume into the standard equation in paragraph (b)(1) of this section for that compartment's equipment class. The total MDEC limit for each model shall be the sum of the MDEC values for all of its compartments. Measure the CDEC or TDEC for the model as follows:

(i) For commercial hybrids and commercial refrigerator-freezers where two or more independent remote condensing units are each connected to a separate, individual compartment, measure the total refrigeration load of each compartment separately according to appendix B to this subpart. The CDEC for the model shall be the sum of the CEC for each compartment, FEC, LEC, AEC, DEC, PEC, and OEC.

(ii) For commercial hybrids and commercial refrigerator-freezers where two or more compartments are connected to one remote condensing unit, measure the total refrigeration load of the model according to appendix B to this subpart. Calculate a weighted average adjusted dew point temperature for the model by:

(A) Multiplying the adjusted dew point temperature of each compartment by the volume of that compartment,

(B) Summing the resulting values for all compartments, and

(C) Dividing the resulting total by the total volume of all compartments.

Calculate the CEC for the model using the total refrigeration load and the weighted average adjusted dew point temperature. The CDEC for the model shall be the sum of the CEC, FEC, LEC, AEC, DEC, PEC, and OEC.

(iii) For commercial hybrids and commercial refrigerator-freezers connected to a self-contained condensing unit, measure the TDEC for the model according to appendix B to this subpart.

(c) The energy conservation standards in paragraph (a) of this section do not apply to chef bases or griddle stands, buffet tables or preparation tables, blast chillers, blast freezers, or mobile refrigerated cabinets. The energy conservation standards in paragraph (b) of this section do not apply to buffet tables or preparation tables, blast chillers, blast freezers, or mobile refrigerated cabinets.